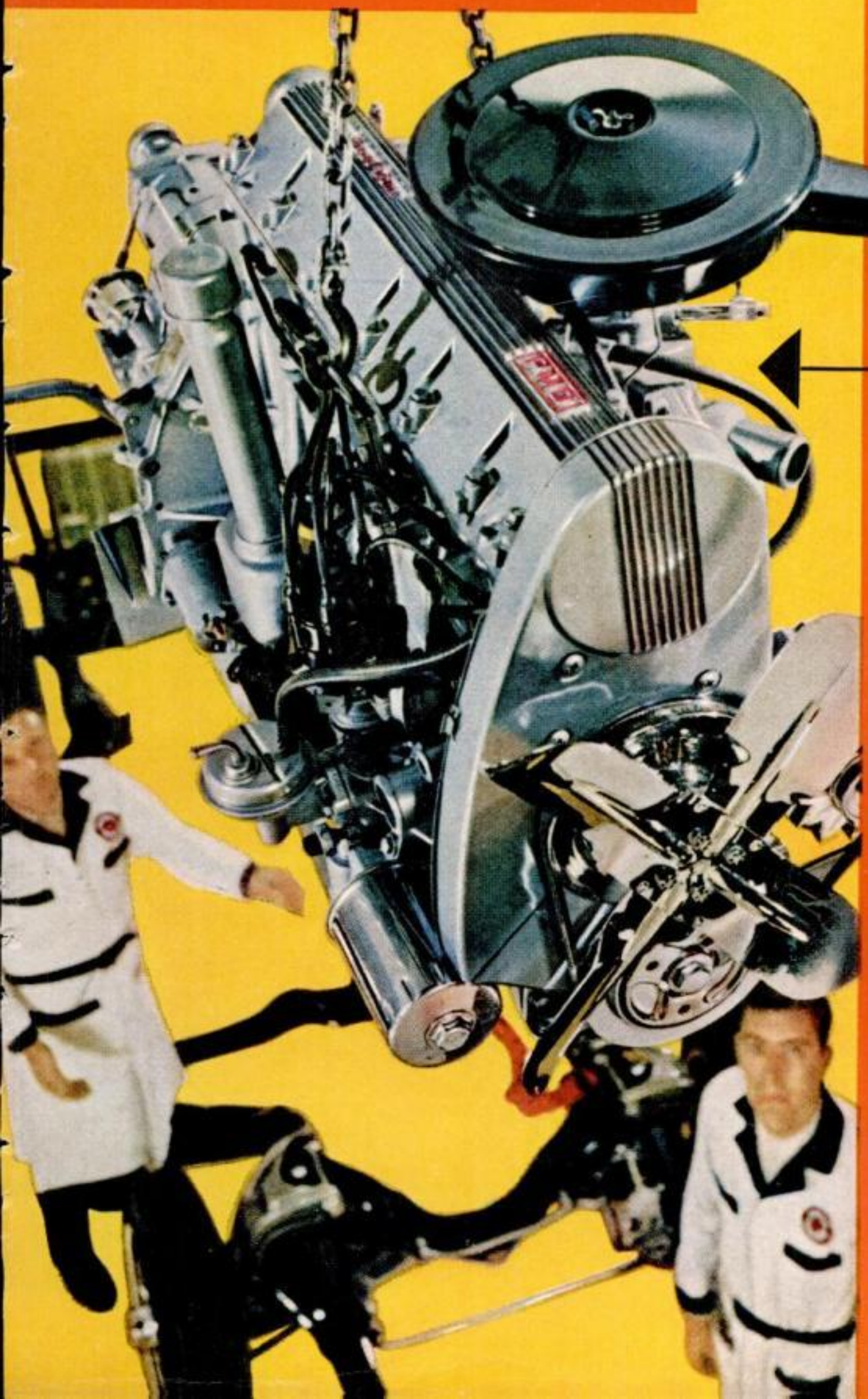
AUGUST 1965 35 CENTS

Popular Science

Monthly



We Built a Home TV Tape Recorder (So can you!)

10-Second Photos with New $20 POLAROID

PONTIAC'S Hot New Overhead Cam ENGINE

How to Wire Your Yard

ELECTRONIC BOATING AIDS FOR FUN AND SAFETY

Great new taste: pipe tobacco in a filter cigarette!

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Your house always generates ordinary moisture (appliances, showers, cooking all cause moisture). That moisture tries to get out through your paint job. Ordinary oil-base paints won't *let* it out. You get blistering, then the kind of peeling you see in the picture (and on your house?).

Du Pont Lucite® House Paint has been proven to resist blistering and peeling better than oil-base paints. It also dries far faster and holds its color much longer than oil-base paints, goes on without a priming coat (except for spot priming bare places), goes on over damp surfaces (just after a rainstorm, for instance), goes on over wood, masonry, stucco—any surface—and cleans up with just soap and water.

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...THROUGH CHEMISTRY

Less work . . . more wear

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Founded in 1872
Vol. 187 No. 2

Popular Science

Mechanics and Handicraft ®
Popular Science ®
Monthly

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Cover photo by Dick Clapp
August 1965

Think you know cars? Here's your chance to match wits with some champion mechanics. Page 146.

Firsthand report on the Air Force's Survival Test. Could you have passed it? Page 62.

At last: a kit TV tape recorder. PS Electronics Editor tells what it's like to build and use it. Page 102.

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Elmer's Instant Spackling Paste is a ready-to-use compound that puts an end to wasteful and messy mixing. Just press the stem of the aerosol container for the right amount to fill holes, cracks and low spots in plaster, wood or composition walls before painting. Dries in minutes and sands to a feather edge.

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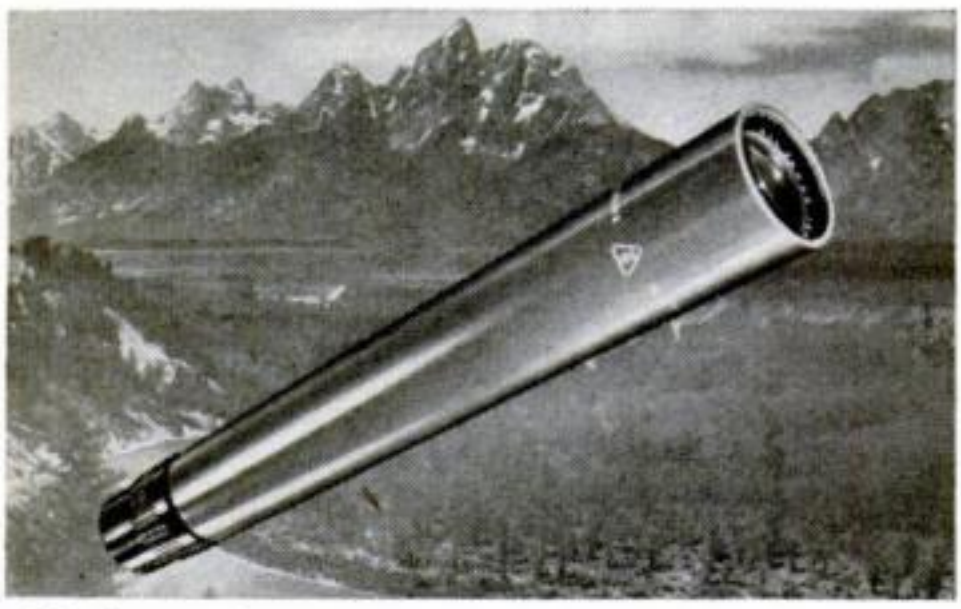

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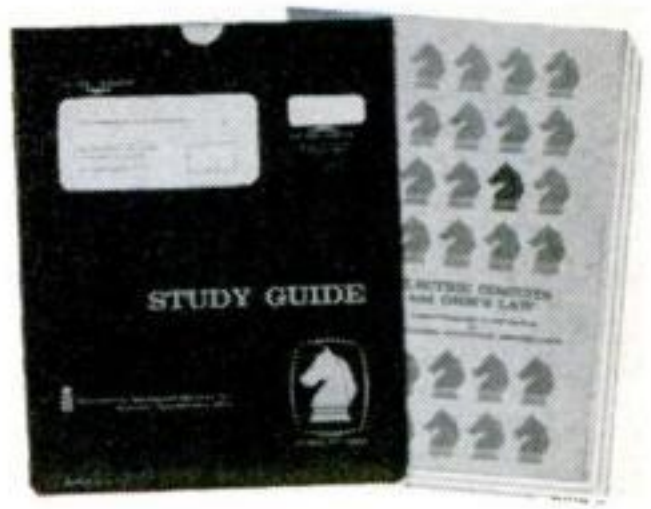

No matter how much knowledge you have about electronics, it's of little use **unless you can answer questions about the field.** Your ability to answer questions tells others that you know what you're talking about. It strongly indicates that you possess solid, working knowledge of Electron Theory.

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- E13 ☐ Audio Frequency Amplifiers
- E14 ☐ R-F Circuits
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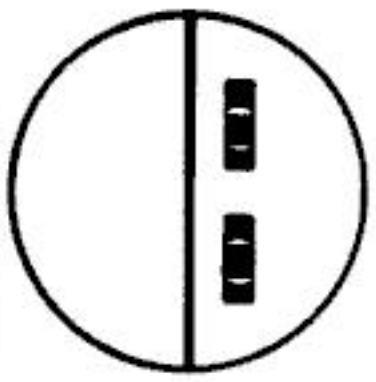
PS readers talk back

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave., New York, N.Y. 10017.

Signs of Exasperation

No wonder people find signs confusing ["Stupid Signs Can Kill." May]—the European no-passing sign (page 106) shows two cars passing. I would change it like this (top):



To keep drivers from entering one-way exit ramps, why not mark ramps like this (bottom), repeating the signs about every 20 feet.

J. G. Campbell,
Lake Charles, La.

Plea for More Science

I have enjoyed eight issues of PS so far, but why call your magazine Popular Science? The number of science articles is so small, science seems just a sideline. Sometimes articles on cars are as numerous. Boating, photography, and ideas for the home also take up a lot of space. "What You Know About Blood," "Medicine Aims for the Impossible," "Big Gamble: Organ Transplants." are the articles I enjoy.

Glenn Merrill, Baton Rouge, La.

Postscripts to Car Air Conditioner

Readers inspired to go ahead with "A Car Air Conditioner You Install Yourself" [Mar.], will have saved around $100. But they should be cautioned on the dangers of liquid Freon. It can cause blindness by freezing the cornea.

Also, you show the Freon can in an inverted position during charging of the system. Do this, and liquid Freon rather than gas is admitted to the suction side of the compressor, damaging the reed valves of the compressor.

Some installers up-end the can when it is about empty. Better practice is to immerse the Freon in a can of warm water when it is apparent that it's nearly empty.

J. Fleischer, San Antonio, Tex.

The safe handling of Freon is most important. Space did not permit duplicating detailed information in the kit maker's manual. The kit maker does say, however, "turn Freon can upside down until it empties." We'll tell them of your hot-water method.

Way Out in Space

You had us space-achievement buffs looking twice before finishing "The Space Race: Who's Ahead?" [June].

You say Bykovsky was "carried around earth for 34 hours" and Tereshkova, first woman in space, "stayed up for 119 hours." How could Bykovsky make 81 orbits in 34 hours, while Tereshkova made 48 orbits in 119 hours? That's almost enough to make von Braun hand in his missiles and call it quits!

George Wirth, New Orleans, La.

Woops! While compiling all those figures, the editor, himself, went into orbit. The 34-hour figure, of course, was lifted from the item on Cooper in the right-hand column as the editor whooshed by.

Twins vs. Brothers

Jim Roe asks "Are Two Outboards Better Than One?" [May]—then does a poor job of answering the question. I had two Merc 500s and replaced them with one 650 and one 110 (65 and 10 hp.). My reasons:

I had to use 13-pitch props for a top speed of 38 m.p.h. at 5,500 r.p.m. But with these props, if you operate on one engine, you get a speed of four m.p.h. So you haven't the safety you imagined you had. Use 10-pitch props and your top speed is only 30 m.p.h. On my boat, at planing speed, cutting out one engine and pulling it would result in 28 m.p.h. So with the right props for one engine, you gain some two m.p.h. and all the fuel consumption that goes with it.

As for trim—with two engines, I found they had to be set with a $\frac{1}{16}$" toe-in (measured at steer plate), much like a passenger car. This eliminated the fin spray effect, which also cut horsepower.

There was noise (twice as much), weight on the transom of 310 pounds, and I needed tachs on both engines to operate properly.

With one 65-hp. and a 15-pitch prop, I get 34 m.p.h. at 5,200 r.p.m., ample for our needs. With the little 10-hp. job and a seven-pitch three-blade prop. I get eight m.p.h.

I burn 3½ gallons an hour vs. 6½ for the twin 50s (where did Roe's 12 g.p.h. figure come from?) and only have one engine wearing out. The little 10 will last me many years as an emergency engine.

H. N. Roberts, Indianapolis.

We Flunked This One

In his article "Are We Licensing Drivers to Kill?" [June]. James R. Berry, referring to the State of Florida, states that "responsibility for examining drivers lies with the county—with

CONTINUED

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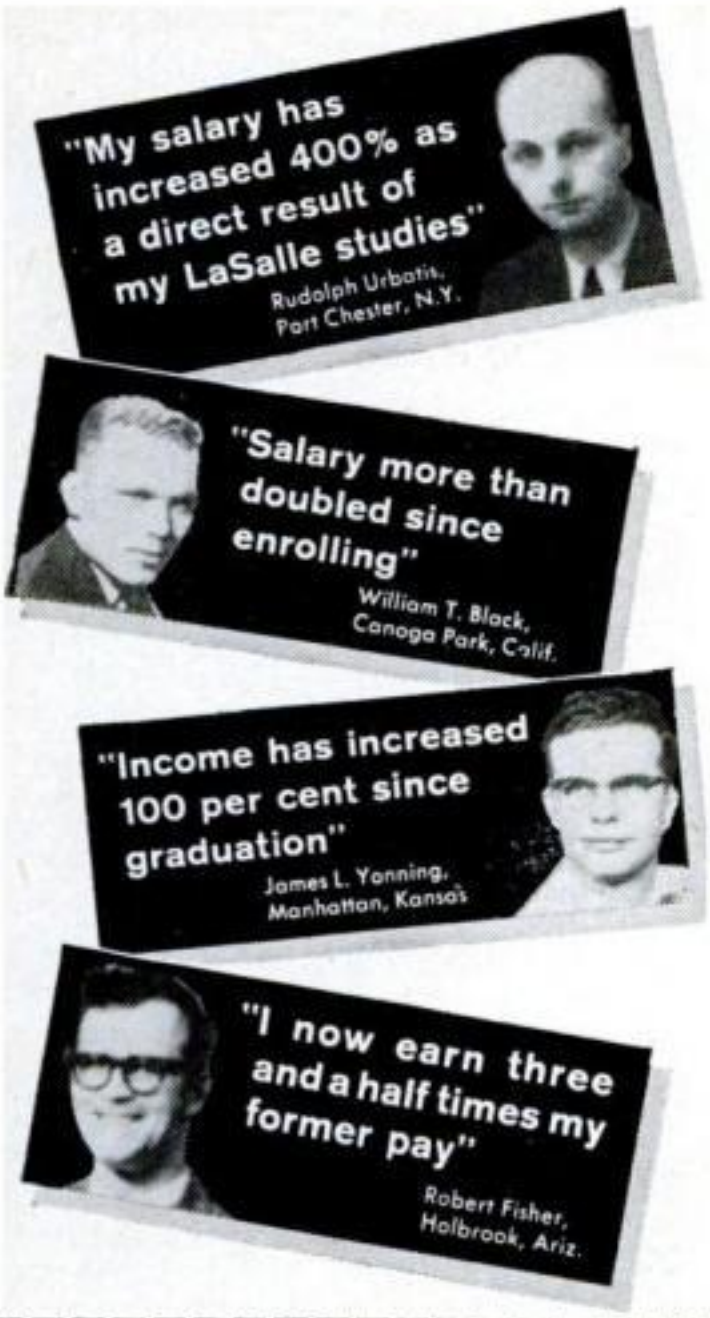
WHO ELSE WANTS A BIG RAISE IN PAY?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College ..... years
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PRESENT EMPLOYMENT:

Kind of position .....

Hours of work ..... A.M. to ..... P.M.

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Estimated spare hours per week available for study .....

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part of the fees legally settling in officials' pockets for their trouble." This statement is incorrect. At no time since driver licenses have been issued in the State of Florida has the responsibility of examining been in the hands of county officials. It has always been the responsibility of the Department of Public Safety.

H. H. KIRKMAN, DIRECTOR
State of Florida
Department of Public Safety
Tallahassee

Reports author Berry: "According to Florida licensing statutes, county judges are charged with issuance and sale of drivers' licenses. When a prominent safety authority acquainted me with this, I mistakenly assumed that examining drivers was part and parcel of issuing and selling licenses. It isn't, and an apology to Florida is in order. Actually, license examinations are handled by '. . . state highway patrol officers, other officials, or private citizens . . .' appointed by the Dept. of Public Safety. After an applicant passes the test, the county judge takes over."

The Voice of Experience

In my early twenties, I saw the need for self-improvement ["Educating Yourself," May] and enrolled for a course in steam-electric engineering. Thanks to ICS I have had a very gratifying career in power-plant work. I have worked in many capacities from repairman to plant superintendent. During the past eight years it has been our privilege to help construct and put into operation one of the first gas and steam turbine cycles in this country.

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J. A. CARROLL, Supt.
Rio Pecos Station, Girvin, Tex.

"No Matter What You Do . . ."

Richard Petrow ["8 Boating Crises," May] recommends turning towards the approaching vessel bearing down on you on a broadside collision course. Wouldn't this double closing speed and cut time for maneuvering? If each boat were doing 20 knots they'd be approaching each other at a combined speed of 40 knots. Also, any impact would be that much greater. Surely the best tactic would be to stop dead in the water and lean on the horn.

ARTHUR VENITT, Jamaica, N.Y.

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U.S. Army Photos

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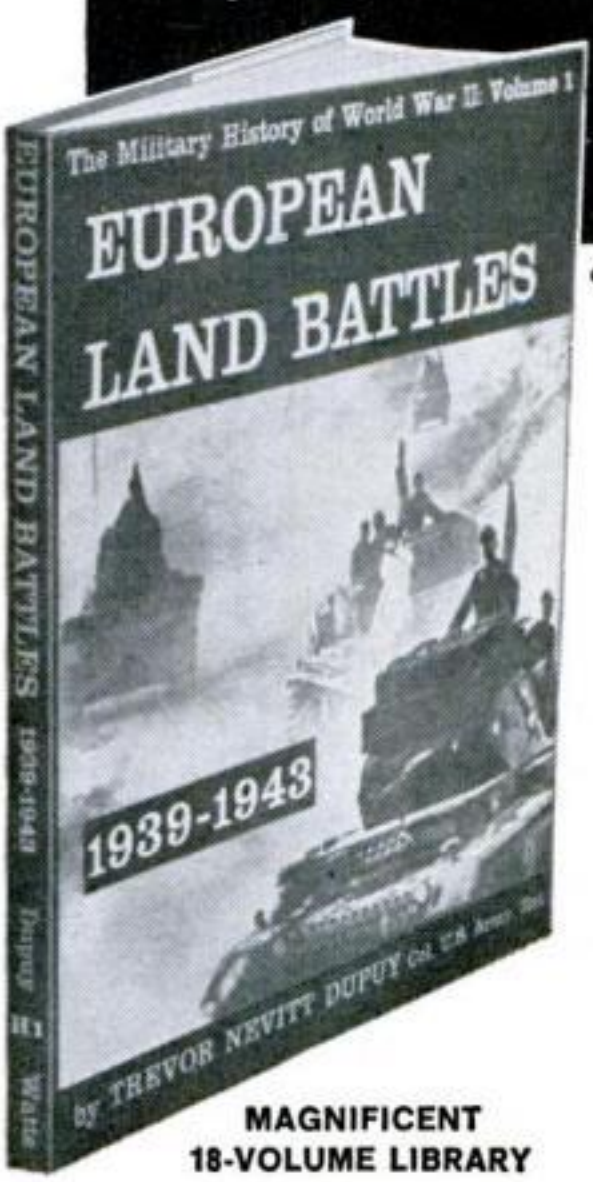

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►***"When we change the oil in our car we wash out the engine with kerosene. Does this help it?"—Eugene King, Plateau, Ala.***

This can be very harmful! Kerosene cannot lubricate, and some of the engine parts cannot do without oil for more than a second or two. Besides, kerosene can loosen up trash in the lube system, and pass it through the engine again. Just use good oil and change filters frequently.

►***"How come Chevrolets monopolize the short tracks in open competition and sprints? The only cars I see doing well on the quarter-, third-, and half-mile tracks are super-mod Chevies with 327 engines. Why aren't there more Dodges, Pontiacs, Fords, and so on?"—James Britt, Memphis, Tenn.***

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►***"I've got an oil burner. My mechanic says the valves seat so well that the oil passes through the rings to the combustion chambers. He also tells me that a ring job would cost $100, and the old car isn't worth it. I'm using cheap bulk oil, one quart each 200 miles. Will the cheap oil hurt the car more?"—Frederick F. McLean, North Bend, Ore.***

Your mechanic was right about the ring job. If you want the car to run better for a little while–before it finally dies–give it a shot of one of the many miracle drugs, advertised as "motor overhaul," etc. Meanwhile, the cheap oil won't hurt the engine any more than it's already hurting.

►***"My '64 Ford Falcon Ranchero with a V-8 and four-speed transmission has 6.50-by-13 tires and standard springs. Last summer I hauled a 16-foot house trailer, bringing the rear end very low. It was recommended that I switch to 14-inch wheels with 7.50 tires. Should I also put on H-D springs or some other shocks like Delco Super-Lifts?"—C. Johnson, Orinda, Calif.***

I'd suggest you install every bit of Ford factory equipment for heavy hauling on that model car. You'll find they've spent a lot of time and money solving this problem, and have the very best heavy-duty parts to do the job right.

►***"What is the best way to check out which is at fault, the alternator or the regulator, when there is no charge? When the charge is too high? Do I need special instruments to do the testing?"—L. C. Green, Seattle.***

The best way is to leave the electrical-supply system alone. It takes special equipment to check an alternator system, and the procedure varies from one brand to another. A faulty hookup–and adios, alternator.

►***"Would it be wise to floorboard the gas pedal on my '64 Chevy 195-hp. engine once***

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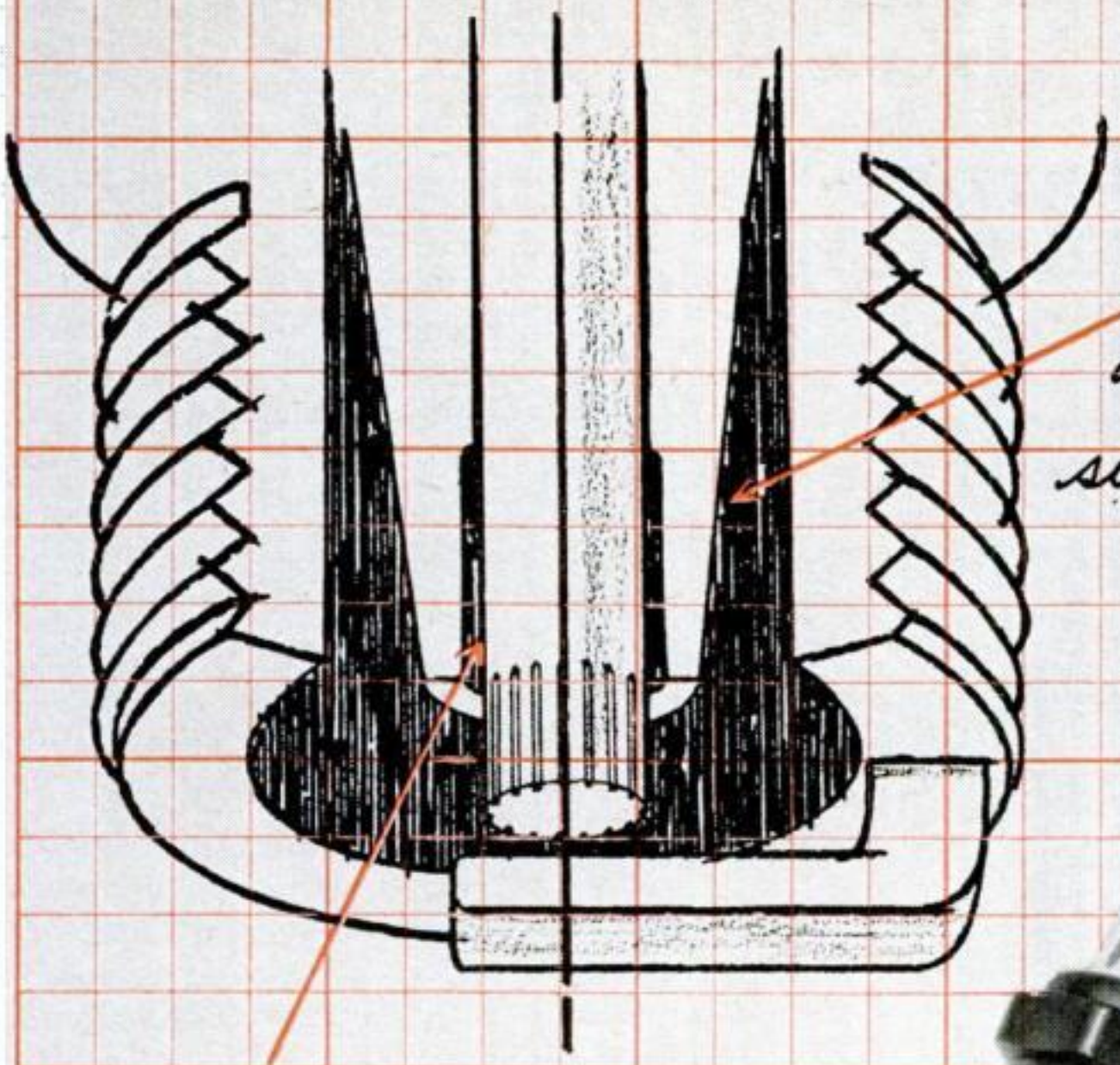

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in a while to get the carbon out of the spark plugs?"—Clifford Olivero, Detroit.

A car that runs in heavy traffic and operates at low speeds much of the time would like very much to get a couple of hours on a freeway to burn out some of the deposits from the combustion chambers and plugs.

►***"The mechanic who looks after my '64 Meteor tells me it is all right for him to lift the car by putting the jack under the differential. I say it puts too much strain on the axle. Who's right?"—Otto Preiss, Oakville, Ontario.***

Your mechanic is right, as far as most cars are concerned. However, you have a point. Some rear housings are too weak, especially with the trunk loaded, and actually could take a "set" if raised this way. Most mechanics know which ones are safe.

►***"I've heard that diesel fuel added to gas makes a good, inexpensive upper-cylinder lubricant, lengthening car life. If you agree, in what proportion should it be used?" —T. J. Lartigue, Baton Rouge, La.***

I wouldn't agree even if I *saw* it, let alone heard it! Today's four-cycle engines are designed to get along just fine without a top-end lube. Use a good, name-brand oil and, if you like, flush your engine each spring with one of the products specifically made for the purpose. The diesel fuel won't hurt the carburetor, but it could foul the plugs.

►***"I have a '63 Studebaker Hawk, 289 inches, two-barrel carb, four-speed Borg-Warner floor shift, and 3.31 axle. Could I change to an automatic transmission? What breed would be the most suitable? Also, how can I stop the car from idling so rough in hot weather and heavy traffic? It's worse with the air conditioner on."—M. C. Hodge, Dallas.***

Putting in an automatic would mean a lot of work and expense, and your car won't have the same performance it has with that four-speed manual. If you must change, use a Warner. The rough idle at low speed probably is caused by the carburetor running over-rich in that range. Try a needle and seat that uses a neoprene seal. Set the float on the minimum side. Anything you

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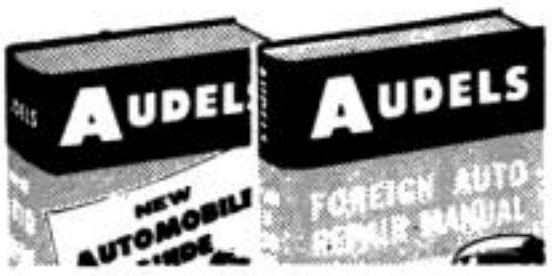

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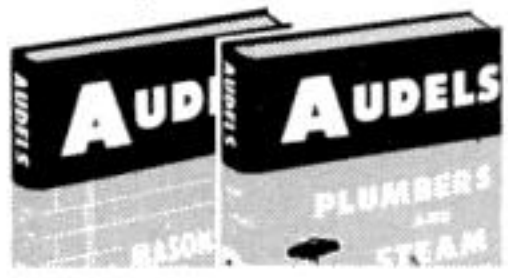

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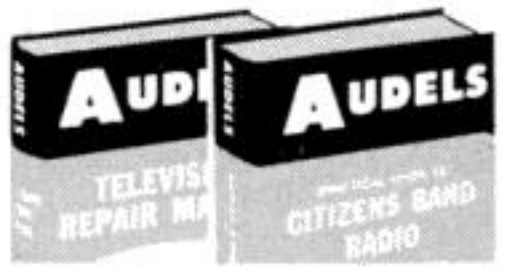

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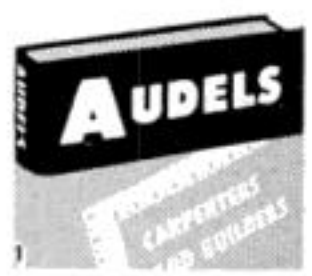

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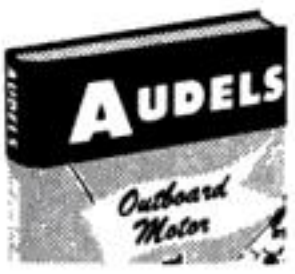

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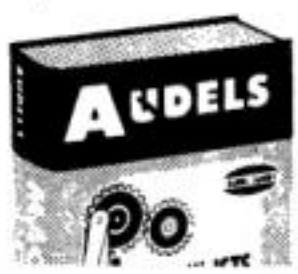

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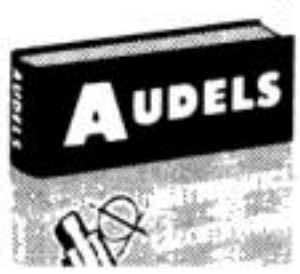

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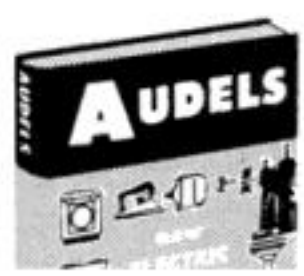

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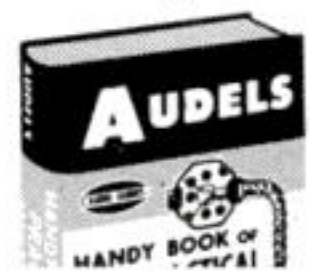

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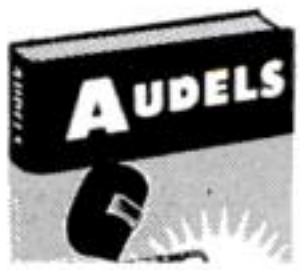

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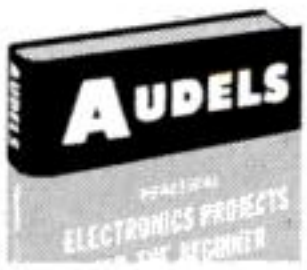

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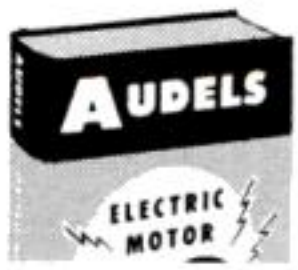

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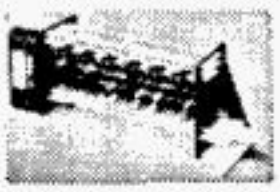

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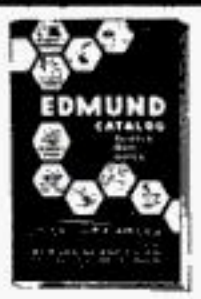

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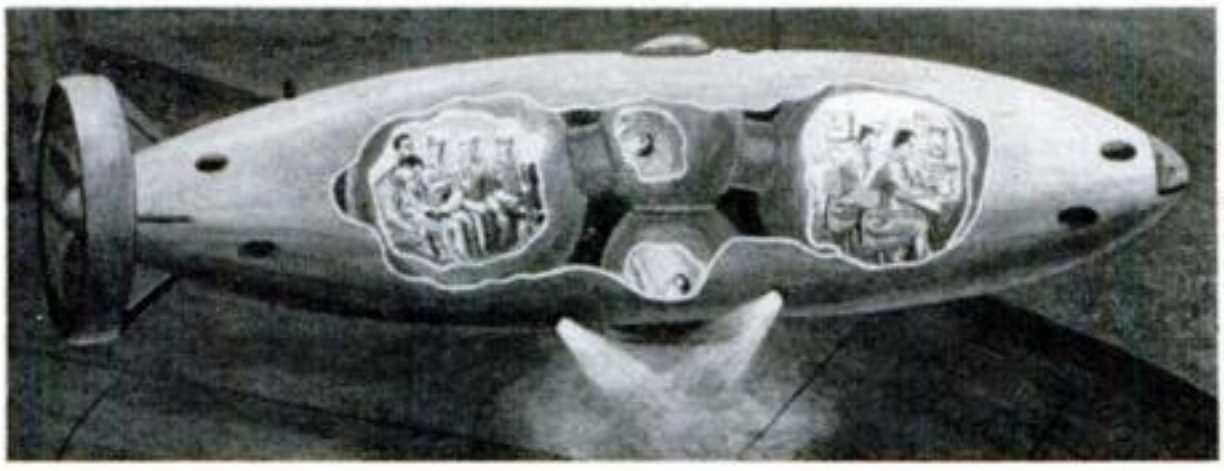
SCIENCE *Newsfront*

BY WALLACE CLOUD, PS SCIENCE EDITOR



Rescue submarines to be built by the Navy

Since the loss of the Thresher, a Navy group has been working hard on an improved undersea rescue system. It has now released the preliminary design of a 40-foot rescue submarine, shown above, which will fit into a C-141 military transport plane.

The vessel's bottom bell, or hatch, mates with the escape hatch of a disabled submarine. Survivors climb into a rear sphere, which can hold 15 men. Crew and controls are in the forward-sphere cockpit.

Designed for a depth of about 4,000 feet, the experimental rescue submarine will be used for ocean exploration in what is hoped to be long intervals between actual undersea rescues.

A new Air Force project: digestible dentifrice

A dental research team at the School of Aerospace Medicine, San Antonio, has developed a toothpaste you can swallow. It's called Astro-9.

For long space flights, Air Force dentists reasoned, conventional toothpaste is out—you can't take a chance on that foamy stuff floating around the cabin during weightlessness.

Astro-9 is digestible—it contains no detergents. Its abrasive is free of calcium, so as not to upset the body's calcium balance.

The new toothpaste has been tested in 30-day simulated space flights. Dr. Ira Shannon, in charge of the Astro-9 project, says that one volunteer was upset about swallowing his toothpaste: "I told him it would be no worse than the purified urine he'd be drinking during the test."

Getting to the heart of the antimatter

Ever since Alice stepped through the looking glass some people have wondered if a world somehow the op-

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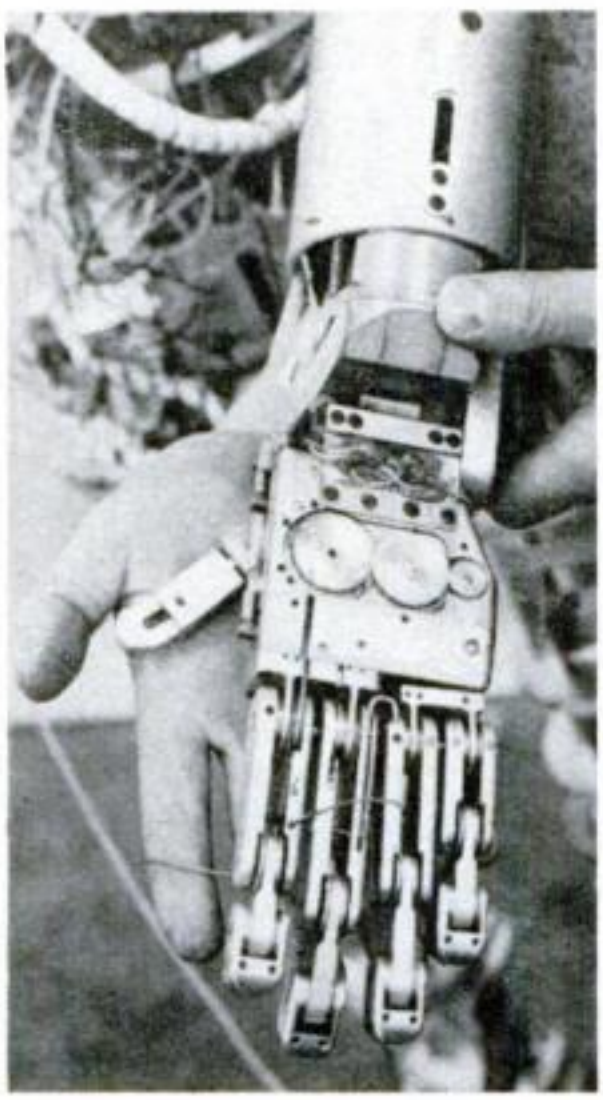

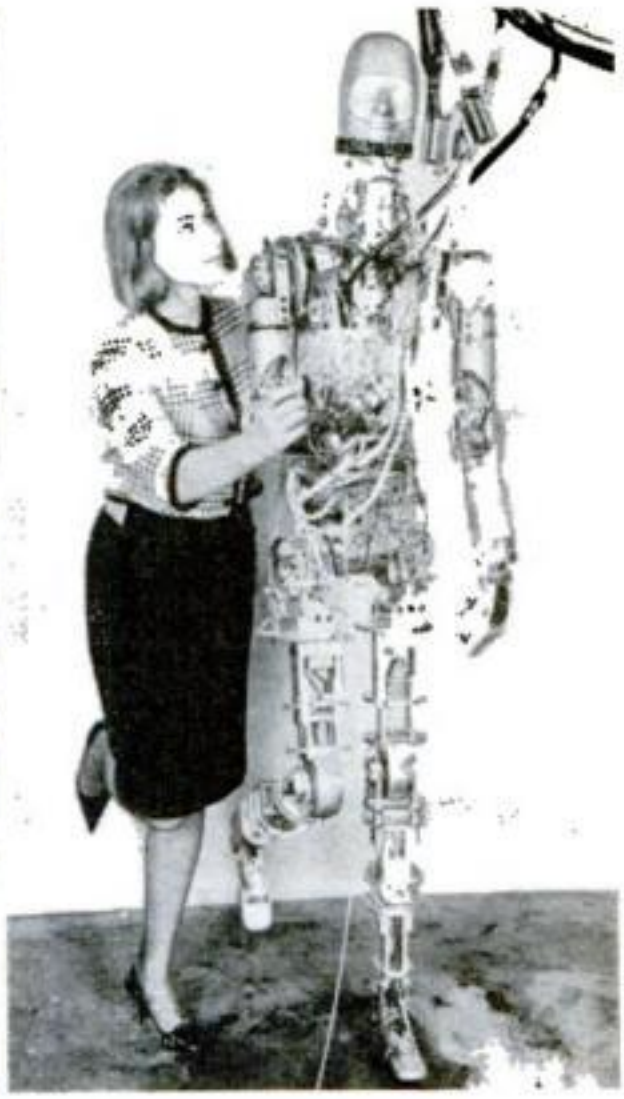

Robot astronaut will model NASA space suits

This 230-pound robot is a tailor's dummy. Built for NASA by IIT Research Institute, Chicago, it can shrug its shoulders or clench its fist. Oil pistons move all 35 joints and measure the force exerted, to help design comfortable space suits. Its height adjusts: 5′5″ to 6′2″.

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Science newsfront continued

posite of ours might exist. Columbia University physicists now say this isn't improbable—it would be a world built of atoms of antimatter. They've discovered the first "complex atomic nucleus" of antimatter.

The nucleus is an antideuteron, the antimatter counterpart of the nucleus of an atom of deuterium, or heavy hydrogen. The nucleus is composed of an antiproton and an antineutron.

Antimatter is the mirror image of matter —its complete atoms would consist of negative nuclei surrounded by positive electrons, and they would have other properties that are the reverse of matter. There isn't much antimatter in our world of matter, since the two annihilate each other on contact. However, physicists have succeeded in producing many kinds of antiparticles from energy with the giant particle accelerators sometimes called atom smashers.

The antideuterons were produced at Brookhaven National Laboratory by bombarding a beryllium target with high-energy protons from a synchrotron, and were detected by a system of 16 20-ton magnets arranged in a pattern stretching 300 feet from the target. The magnets and associated electronic detectors sorted out and identified the antideuterons in the debris of particles from collisions in the target.

Because of the discovery, Dr. Leon M. Lederman of Columbia said, it is no longer possible to question the basic physics in the concept that worlds of antimatter may exist. It is even conceivable, he said, that antiworlds are populated by antipeople.

Where such antiworlds might be located is unknown. It is reasonable to suppose that there are galaxies, stars, and planets of antimatter in our universe—when the matter of the universe first came into existence, probably an equal amount of antimatter was created. A paradox of this situation is that, according to Dr. Lederman, the flow of time is reversed in an antiworld.

Napping cats help in research on dreaming

Take a man's dreams away from him, and he is in bad shape. The same thing appears to be true of cats, psychologists at the University of Delaware report.

Dream deprivation is meant quite literally in this line of research. Sleeping sub-

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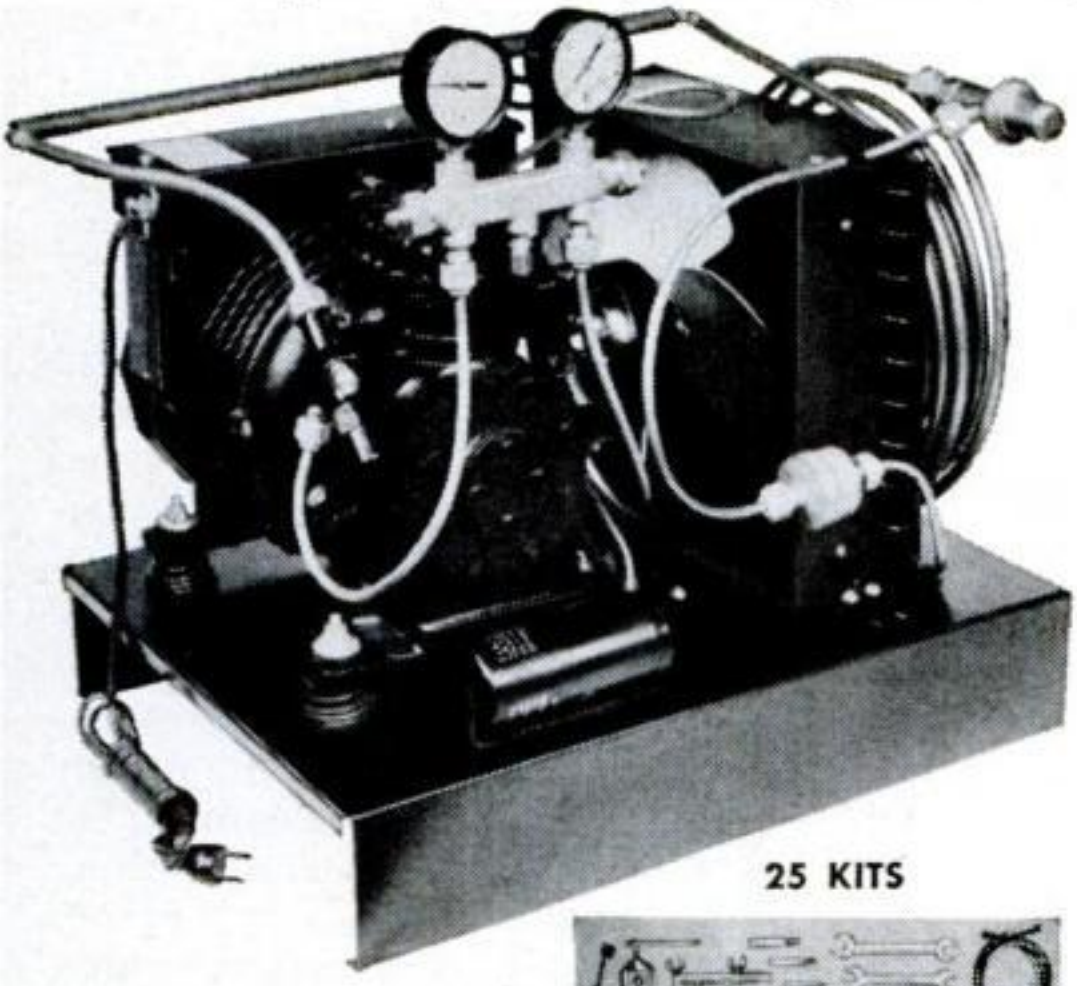

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Many earn money while learning

Since the CTI course includes training with real equipment, many students start service work soon after enrolling. They go out on their own, or get a part-time job with a local dealer. Some arrange with food stores, taverns, restaurants, etc., to handle maintenance. Numerous students pay part or all of their tuition through spare-time earnings.

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Science newsfront continued

jects are prevented from dreaming by waking them when they start to pass from dreamless sleep into the dreaming state (the signal, detected electrically, is twitching of the sleeper's eyelids), then allowed to go back to sleep. After this is repeated for a few nights, a human subject becomes irritable and anxious—indicating that people need a certain amount of dream time to function well.

What cats dream about is unknown, but they show the same signs of dreaming as people—rapid eye movements and changes in brain-wave patterns. The Delaware researchers, Drs. Jerome Siegel and Thomas F. Gordon, found that, like people, cats try harder and more often to enter the dreaming state after dream deprivation; when they are allowed to sleep without interruption, they spend an abnormal amount of time dreaming.

Another scientist, Dr. William Dement of Stanford, a pioneer in dream-deprivation research, found earlier that cats deprived of dreams became disturbed and their ability to learn was impaired.

It's a lumpy world, after all

New measurements of satellite orbits have shown that the earth is not exactly pear shaped, as previously thought, but instead is shaped a little like a pyramid with four corners—a tetrahedron.

The pointy corners are not very pronounced—it's still true that the earth is roughly spherical—but there are four bumps, each several thousand square miles in area, distributed like the corners of a tetrahedron. They are 220 feet higher than if the earth were a perfect sphere; on the other hand, the low areas in between are 253 feet lower than they should be.

The top of the pyramid is Ireland, and the three corners of the base are north of New Guinea, south of Africa, and west of Peru. What with the general roundness of it all, this produces a roughly pear-shaped effect, and the equator turns out to be egg-shaped.

The measurements were made by scientists at Johns Hopkins Applied Physics Laboratory, Silver Springs, Md., under a Navy grant. They measured the deviations in satellite orbits caused by the higher gravitational pull of the lumps. ■■

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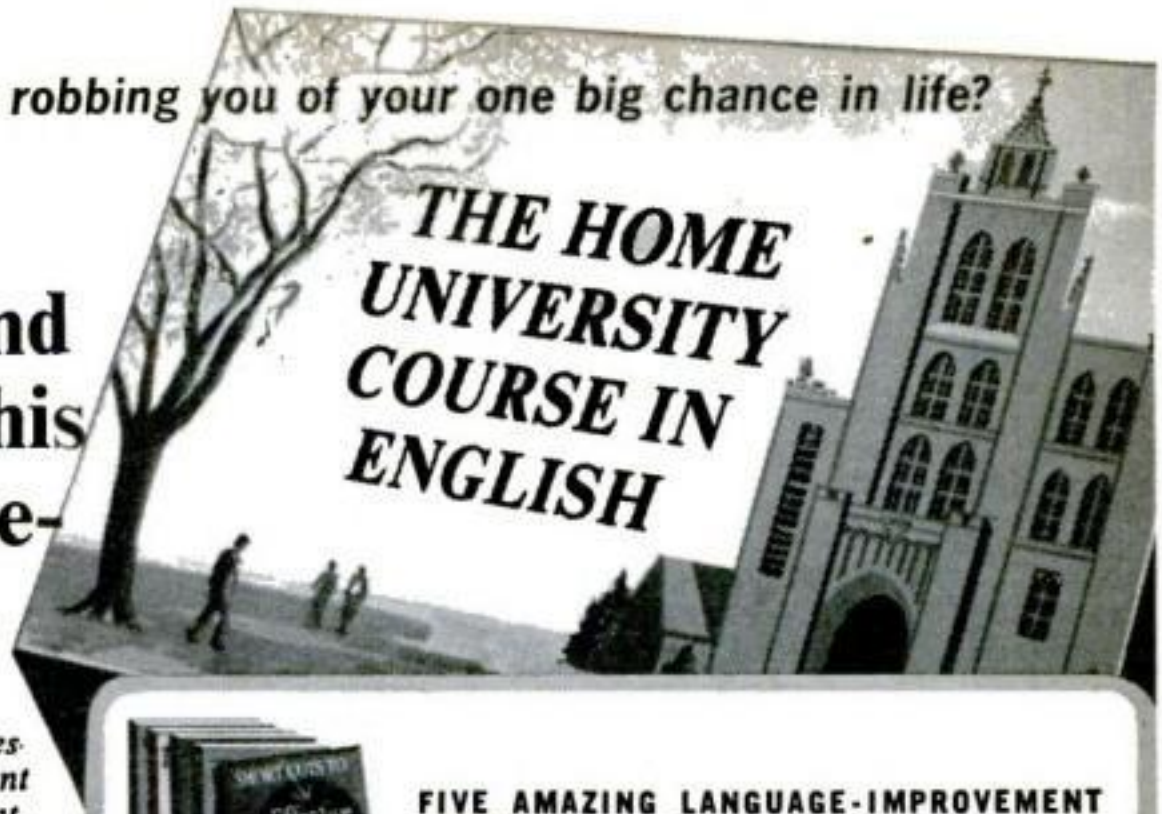

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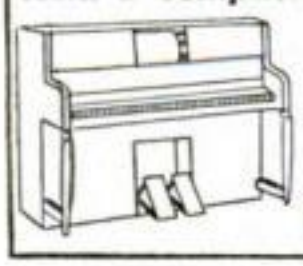

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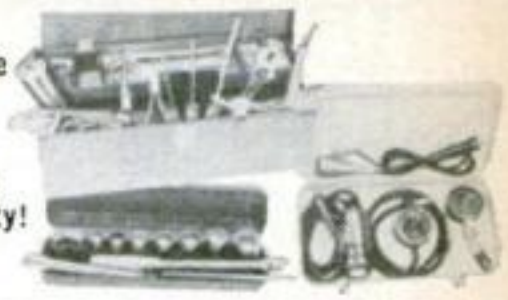

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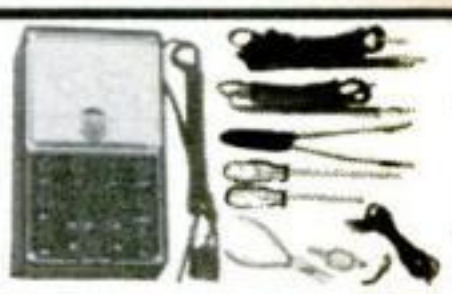

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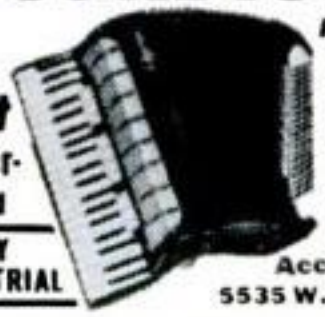

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Detroit report...

FORD AND GENERAL MOTORS MAY BUILD WANKEL ENGINES. Early skepticism about the rotary-piston engine in the U.S. auto industry is giving way to enthusiasm. Ford and GM have completed testing and evaluation programs of twin-rotor Curtiss-Wright engines, and have made inquiries about manufacturing sublicenses. Curtiss-Wright, which holds all U.S. rights on the Wankel, is reportedly asking $15 million for such agreements.

An experimental safety car will be shown by Chrysler this summer. Among its special safety features: no door on the driver's side (to prevent the driver exiting into traffic) and foam padding on almost every part of the car's interior that could cause injury. Chrysler has also come up with a steering system that will eliminate steering-wheel injuries.

A new impact-resistant windshield glass has been quietly introduced on Fords and Mercurys. Although the glass will be no harder, it will absorb twice as much force before a person's head penetrates it. Doubling the thickness of the laminate—polyvinyl butyral—in the windshield sandwich enables the glass to withstand a direct 24-m.p.h. impact, without breaking and becoming a dangerous "horse collar" around the passenger's neck (it just bulges). The old glass would take only 12 m.p.h.

Can aerospace findings be used in cars? That's what the Cornell Aeronautical Laboratory in Buffalo, N.Y., is trying to find out. Under a NASA contract, CAL is sifting through aerospace research and development advances to see if some can be used in automobiles. Some aerospace innovations may lead to improvements in passenger-protection systems, intrumentation, control devices, and suspension systems. Perhaps there are also lessons to be learned about accident prevention. CAL will look closely at the possible application of radar to spacing control and obstacle avoidance, audio cues for lane tracking, and image-intensification devices for driving at night or in fog. Naturally, Detroit is keeping tabs on the CAL studies.

More Toronado details. Barring last-minute complications, Oldsmobile's front-drive car will have a very different silhouette in one respect—there will be no posts or metal strips between the front "A" pillars and the rear "C" pillars. I reported earlier about the elimination of the front-vent window post, but now Olds engineers also have a plan to eliminate the thin strip of metal at the point where the front and rear windows meet. A supplier has come up with a strip of tough transparent plastic to replace the chromed steel normally used on hardtops. Developing the strip was a tough job: It had to be hard as metal on the outside, yet pliable inside to give weather sealing.

Cadillac's automatic levelizer has been one of GM's biggest disappointments this year. Not that it has any weakness or malfunction—people just don't buy it. During the first half of the year, less than five percent of Caddy buyers wanted Delco's automatic leveling (which prevents spring bottoming and keeps headlights level regardless of load). As a result, other GM divisions—and probably Lincoln and Imperial—have backed away from it for the 1966 models.

Those high sales records that have been posted for the past two years haven't brought joy and happiness to everyone in the auto business. Servicing all those extra millions of cars has become an acute problem, and it will get worse. Dealers can't provide quick service to all cars that need it. It's common practice now to make an appointment with the dealer's service department weeks ahead. Auto-company officials are well aware of how the problem can hurt future sales. That's one reason most factories are eager to spend their own money to help dealers expand their facilities.

A Ford for the Future: 50 Ford GT coupes are being built in England for sale through Shelby American. The 289-cu.-in. Fairlane-based V-8 (in the center of the car) is rated at 385 hp. Transmission is a five-speed ZF unit. The streamlined coupe has a top speed in excess of 200 m.p.h. Cost? Only $16,250.

Jan P Norbye
Automotive Editor

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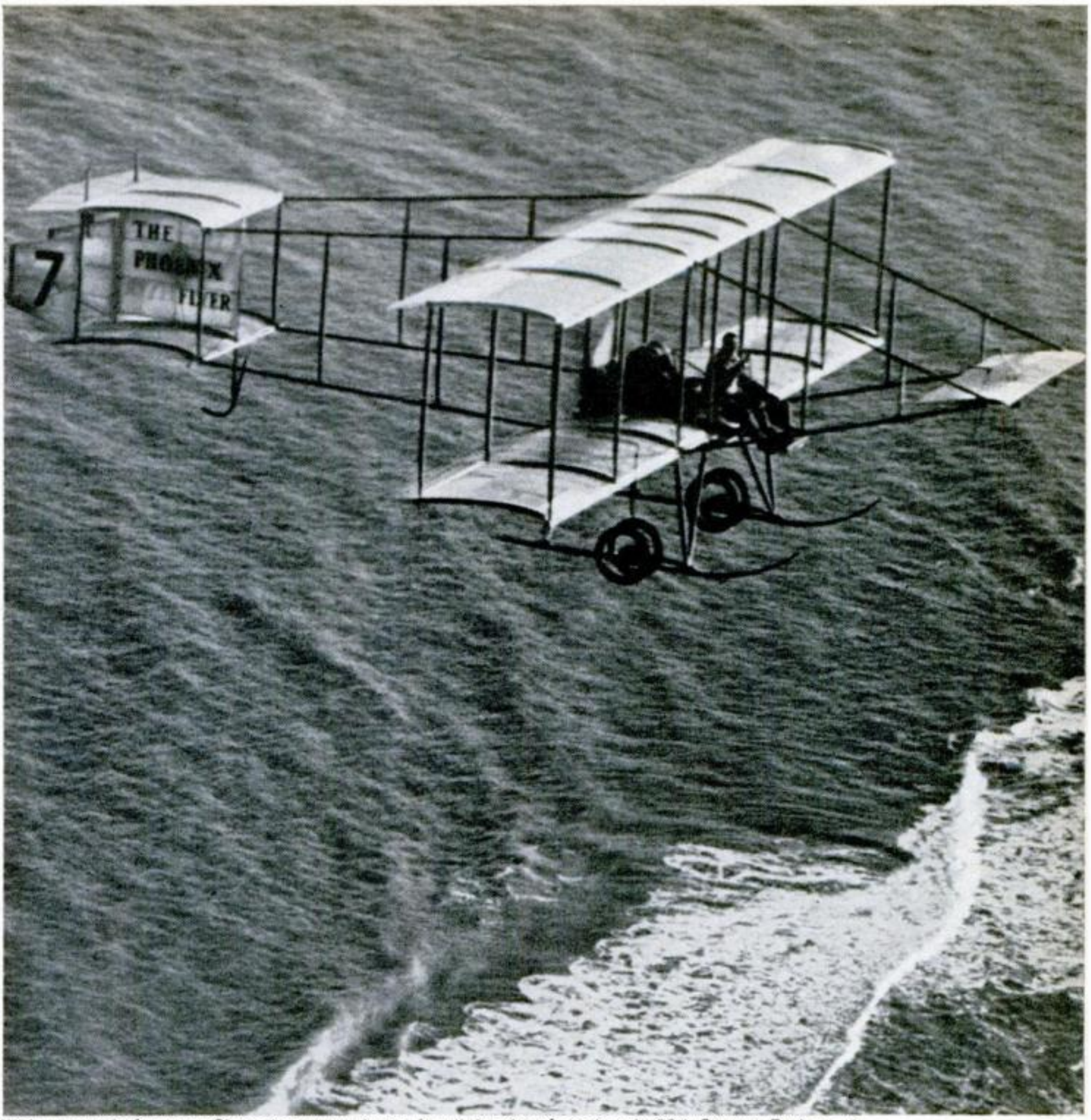

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GETTING AHEAD

A monthly column to help you prepare yourself for a better job

By Dr. Lewis R. Fibel

BUILDERS and contractors, foreseeing a shortage of skilled workers, are setting up training programs in several areas. In Lexington, Ky., the Home Builders' Association is organizing training for carpenters and other craftsmen with government help under the Manpower Development and Training Act.

In Montgomery County, Md., the Masonry Institute (9013 Old Harford Rd., Baltimore) is working with other interested groups on a 12-week training course to turn out a dozen bricklayers a month. A recent Institute survey indicated that 50 bricklayers a month are needed "to keep the crisis from getting out of hand."

"I'm interested in sanitary engineering—particularly water pollution and conservation. What would I study?"—G.C., Sharon, Mass.

Because of its many specialties, sanitary engineering is one of the broadest branches of engineering. The curriculum consists of a basic four-year program, and a fifth year for specialization.

Specialties may be selected from among: industrial-waste treatment, water resources, industrial water treatment, stream sanitation, industrial air analysis, radiation detection and control, bacteriology, food chemistry, industrial safety, and heating and air conditioning.

"I'm 28, married, and have two small kids. I have no trade, but I've worked my way up to a fairly responsible job in a small company. I make pretty good money but see little possibility for advancement. My experience wouldn't be worth much to another company. I'd like to quit and go to a trade school. My wife thinks that's foolish, says I should stick with a sure thing. I'd rather take a chance. What do you think?"—R.S., Florisant, Mo.

I'd hate to come between man and wife. Your first step: Discuss the situation further and *agree* on what to do. The fundamental question to consider is whether you will be permanently satisfied where you are. If not, and you both decide a move is desirable, you would be wise to go to a vocational counselor (at your local high school, a nearby college, a big-city counseling service) who could explore your potentialities and interests, and suggest areas that you might try.

After you've made a choice, you can quit your job and go to school full time, or hold your job and attend part time (in the evenings). The second is safer (you don't burn any bridges), but school-plus-work-plus-family responsibilities can be a tremendous burden.

"Where can I study to be an X-ray technician?"—A.N., San Leandro, Calif.

Training programs in X-ray technology are conducted primarily by hospitals. The American Medical Assn. has approved 715 such schools. Most offer 24-month programs.

Some schools in California: Herrick Mem. Hospital, Berkeley; Highland-Alameda Co. Hospital, Oakland; Franklin Hospital, San Francisco; San Joaquin Gen'l. Hospital, Stockton; St. Francis Hospital, Santa Barbara; City of Hope Medical Center, Duarte; California Hospital, Los Angeles.

"Where can I get a degree in police science? Any home-study courses that could be credited toward a degree?"—C.B., NYC.

A list of 80 colleges that offer degree programs in Criminology and Police Science can be obtained from the Internatl. Assn. of Chiefs of Police, 1319 18 St., N.W., Washington 6, D.C. Some of the programs are four-year ones, leading to a bachelor's degree; more common are two-year programs leading to an associate degree.

You cannot obtain a degree via correspondence study alone, but many colleges offer courses for home study, some of which

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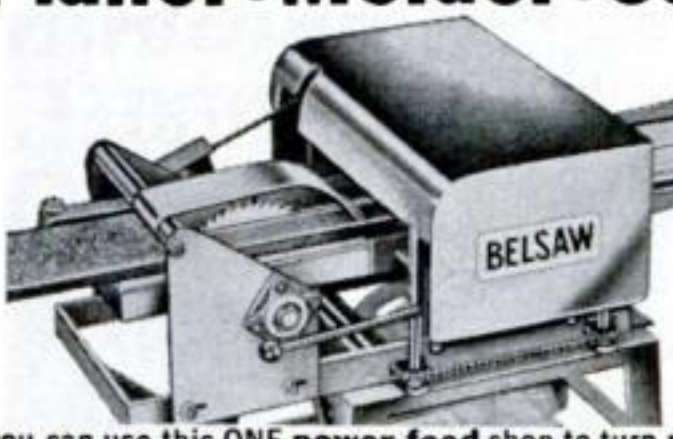

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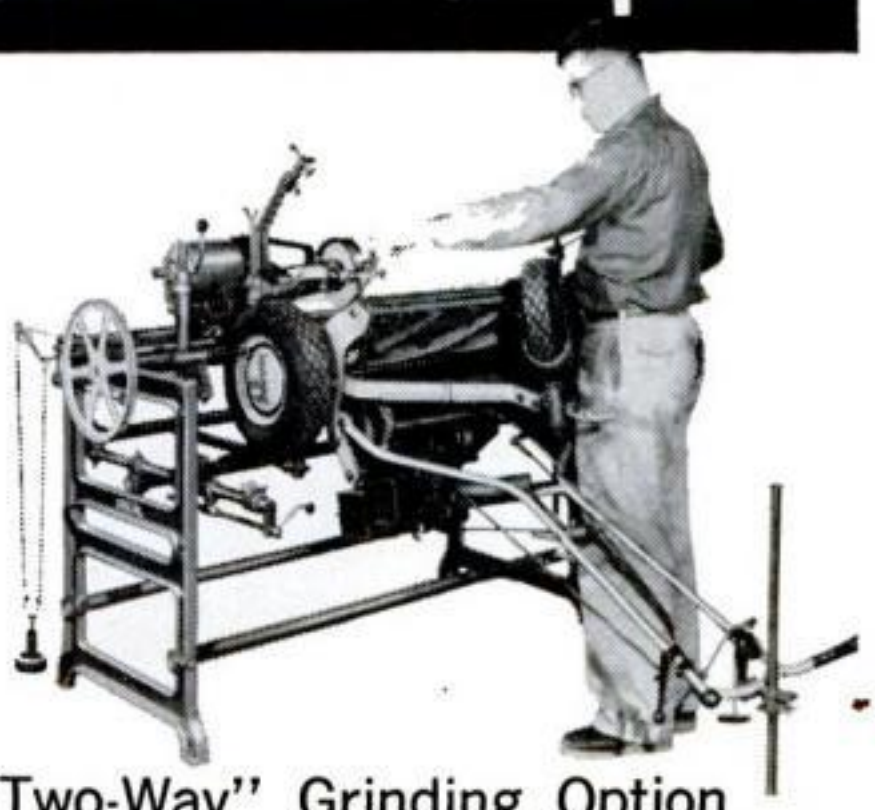

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Getting Ahead continued

might be creditable. Write the colleges on the list mentioned above.

"What are the chances of finding employment on retirement from the Air Force at age 43? I'm an auto mechanic with over 20 years' experience."—J.L., APO NY.

While some companies do discriminate against older applicants on pension-cost grounds, you should have no difficulty. There is a shortage of good, experienced automobile mechanics in all populous areas [see an item on this in "Detroit Report"] and in many instances the pension problem will not arise.

"What are the employment possibilities for court reporters? Any schools?"—B.G.T., Fitch, Tex.

Some reporters use microphones and recording machines to record court proceedings; others take shorthand notes or use Stenotype machines. They may also record proceedings at meetings and conventions, or work for police departments. There is a steady and continuing need for such reporters.

A sampling from many schools: Bryan Stenotype School, 524 S. Spring St., Los Angeles; Walsh School of Bus. Science, 139 NE First St., Miami; Burton Inst., Charlotte, N.C.; Chicago College of Commerce, 27 E. Monroe St., Chicago.

Check under "Schools" in the classified telephone directories of large Texas cities for schools nearer you.

"I'm interested in photography. Can you list a few schools in the East and Midwest?"—M.L.M., Metropolis, Ill.

Many people prepare for careers in this field with on-the-job training, but courses in photography are offered in many colleges, technical institutes, and trade schools. A few colleges offer four-year curriculums with a major in photography.

A sampling of schools: N.Y. Inst. of Photography, 10 W. 33 St., NYC 1; Paier School of Art, 6 Prospect Ct., New Haven, Conn.; Amer. School of Photography, 835 W. Diversey Pkwy., Chicago; Mich. School of Photography, 2030 W. Diversey Pkwy, Chicago; Antonelli School of Photography, 219 N. Broad St., Philadelphia; Rochester Inst. of Technology, Rochester, N.Y.

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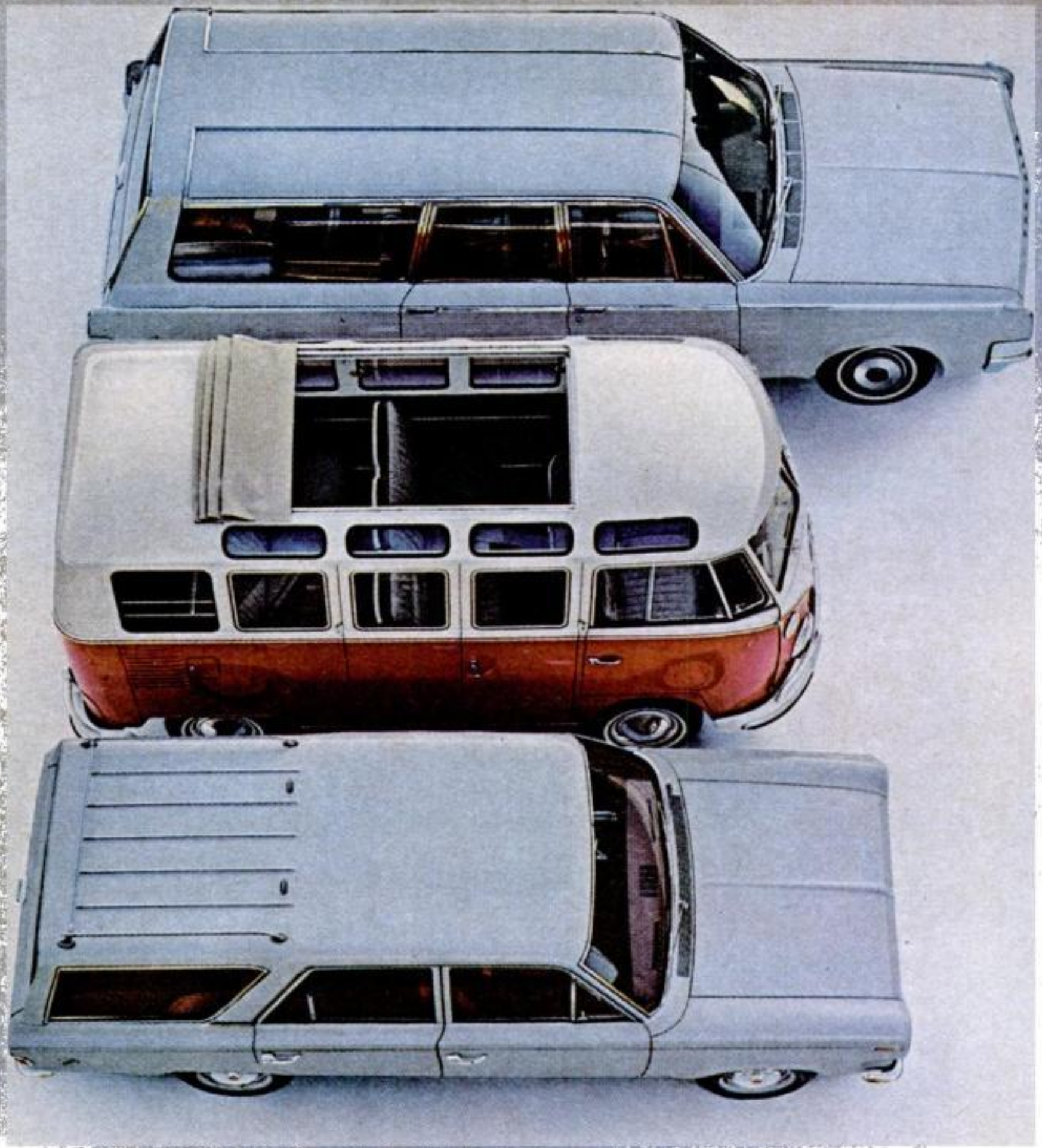

The Volkswagen Station Wagon: Bigger than the biggest, smaller than the smallest.

Even if you own the biggest conventional station wagon made, it holds much less than the Volkswagen Station Wagon.

On the other hand, even if you own the smallest conventional wagon, it's too big to park where a VW can park.

This fact can be simply explained: The more space you waste, the less you have left.

Conventional wagons waste space by having engines under long hoods in front.

But the Volkswagen engine is neatly out of sight in back. It wastes no space at all.

(That same invisible VW engine gets about 20 mpg. And it doesn't use water or antifreeze because it's cooled by air.)

The VW Station Wagon holds more in less space; it is box, all box and nothing but box.

If you wanted a regular station wagon that carried as much as a VW Station Wagon, you couldn't do it.

You'd have to buy two of the big ones to carry as much as our little one.

Which is entirely too ridiculous to discuss any further.

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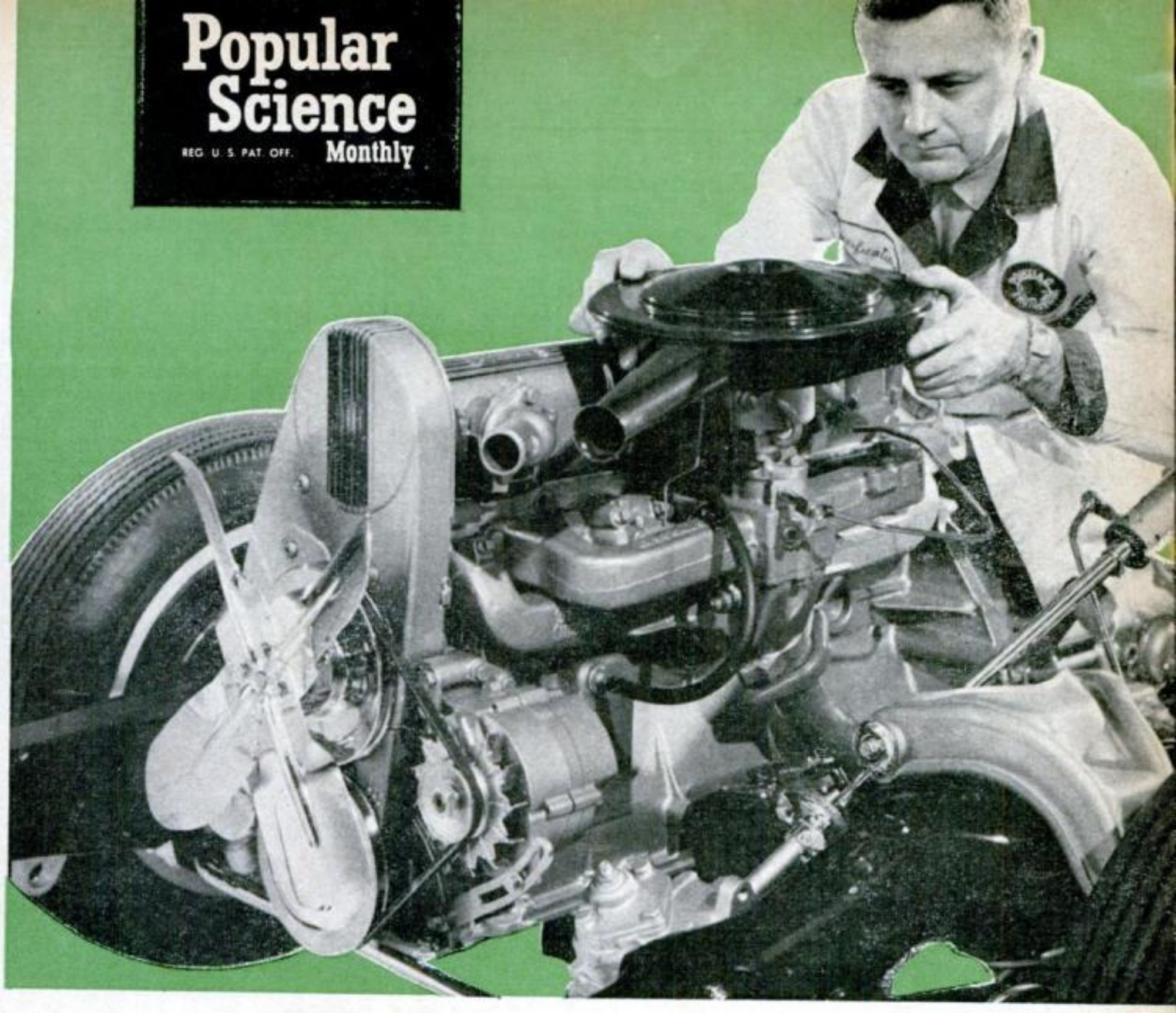

Sensational New OHC Six from Pontiac

Now: first look at Tempest's six with belt-driven single overhead camshaft and zero-lash hydraulic adjusters

By Jan P. Norbye

FORGET the lackluster sixes around you. Forget their lack of glamour and their mediocre performance. Pontiac has created an entirely different breed, more akin to the famous sixes from Mercedes-Benz and Jaguar than to the conventional pushrod six, Chevrolet based, that Pontiac has been using up to now. That six has no family resemblance

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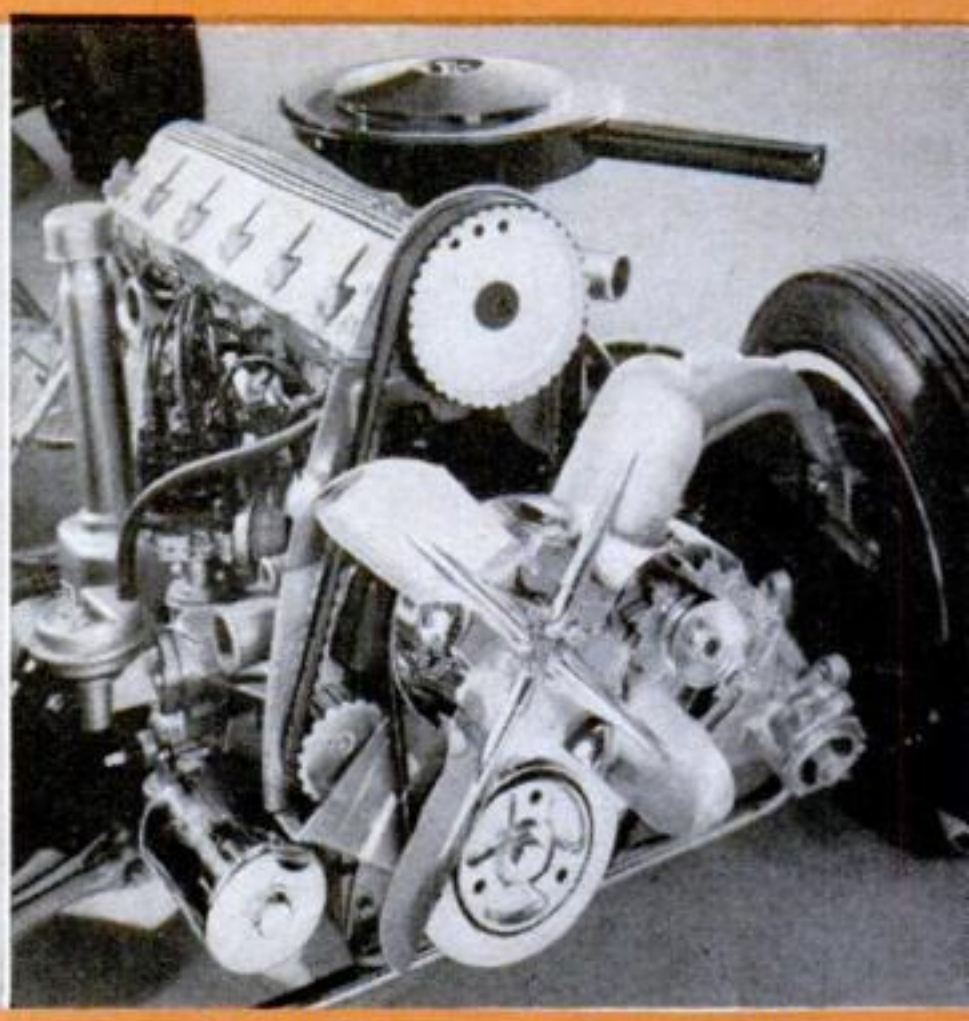
Pontiac's new L-6 bristles with technical originality

Cog belt one inch in width, fiberglass-reinforced, is silent, positive-drive link between the crankshaft, the camshaft, and the shaft that drives the distributor, fuel pump, and oil pump.



Low weight, compactness, and accessibility keynote design. Cross section (right) shows accessory assembly and simple block, with valve-gear detail enlarged.

SPECIFICATIONS	REGULAR	HIGH-PERFORMANCE
Engine type	In-line six	
Bore & Stroke	3.875 x 3.25 in.	
Displacement	230 cu. in.	
Valve gear	Single OHC	
Valve-head diameter:		
Intake	1.92 in.	
Exhaust	1.60 in.	
Valve lift	0.40 in.	0.438 in.
Valve timing:		
Intake opens	12° BTC	20° BTC
Intake closes	36° ABC	44° ABC
Exhaust opens	46° BBC	58° BBC
Exhaust closes	2° ATC	6° ATC
Compression ratio	9.0:1	10.5:1
Fuel grade	Regular	Premium
Carburetion	Single 1-bbl.	Single 4-bbl.
Horsepower	165 @ 4,700	207 @ 5,200
Torque (lb./ft.)	216 @ 2,600	228 @ 3,800

to such hot engines as the GTO or the Grand Prix V-8s, and Pontiac's engineers decided to do something about it.

The first step was to establish that the pushrod six was unsuitable for high-performance development. The next step was to establish design goals for an all-new engine:

- High performance and sustained high-r.p.m. reliability.
- Torque curve suitable for all transmission options.
- Silent operation.
- Low weight and low cost.
- Service simplicity and long life.

The result is a radically engineered in-line vertical six with a belt-driven single overhead camshaft, finger-type cam followers, and automatic zero-lash hydraulic adjusters.

At no time was a V-6 considered; only the in-line six has perfectly even firing impulses.

The lure of OHC. It was the need for high performance that attracted Pontiac to the overhead camshaft. Locating the camshaft in the cylinder head lightens and simplifies the valve gear, reduces valve-spring loads, and practically eliminates the risk of valve bounce. The designers obtain greater freedom of combustion-chamber design and porting. The single overhead camshaft also meets other requirements: cost and durability. By moving the camshaft out of the block and into the head, block casting is simplified. The block also becomes more symmetrical, which means less heat distortion and longer bore life.

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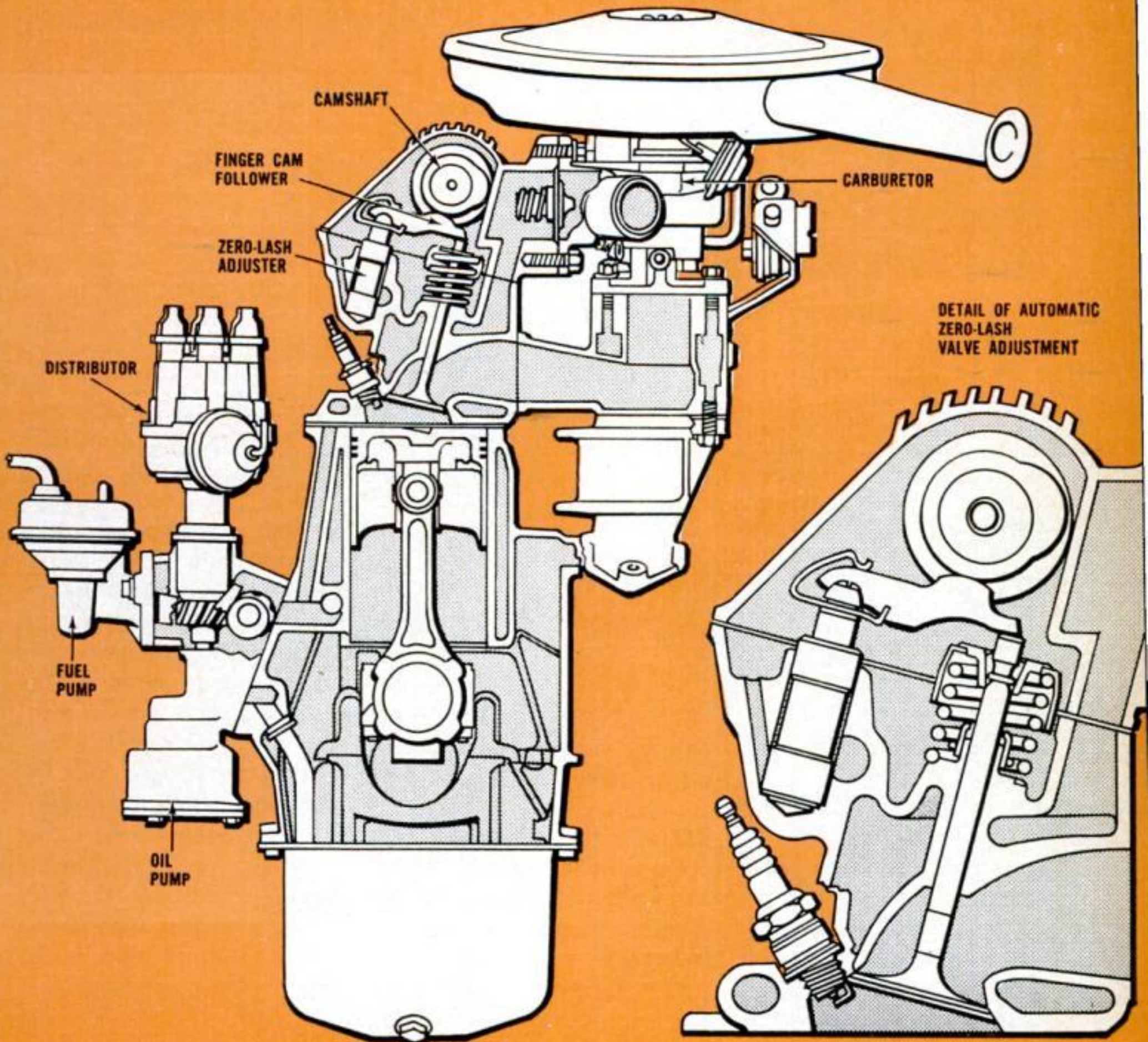
and may spark a whole new generation of exciting sixes



But what about noise? Gear drive to an overhead camshaft is so noisy that it is accepted only on racing engines. Chains are quieter, but have adjustment and wear problems. A chain has little inherent elasticity and must be regularly tensioned to take up the slack. Fluctuating loads in the valve train aggravate this drawback.

Enter the belt drive. Here, Pontiac found the answer. Belt drive is accurate on timing, silent, and surprising—to many of the engineers—in durability. Pontiac's interest in belts dates back to 1959, when an experimental cog belt was fitted on a compressor in use on GM's Arizona proving grounds. It ran for 3½ years without brittleness or cracking.

Prior to a full report on this test, Pontiac felt sufficiently encouraged to begin design of an OHC engine in May, 1961. The first test engines were built about 10 months later. The engine was fully developed by August, 1964, but manufacture

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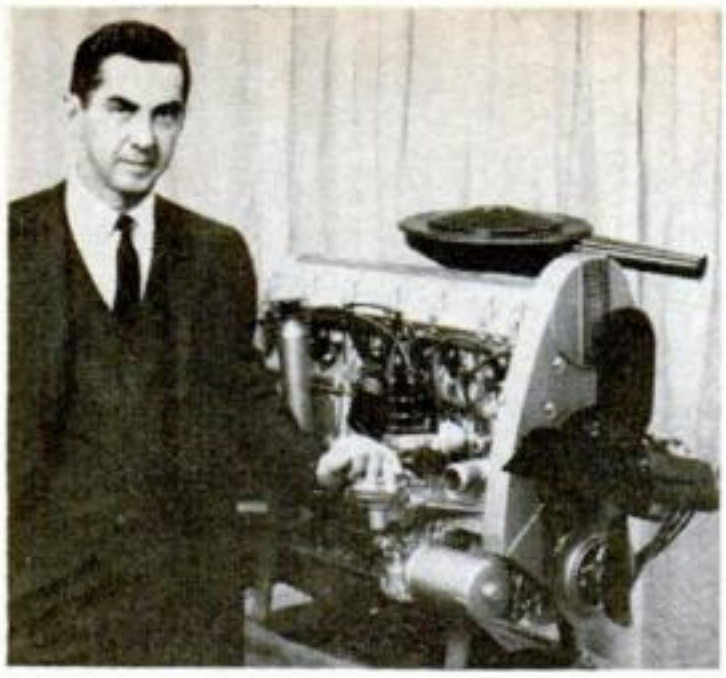


Man and his motor: John DeLorean

Chief engineer John Z. DeLorean, as assistant to Pete Estes, played a major part in the design and development of the first Tempest. He was the father of the GTO and he started the OHC program, ably assisted by E. L. Windeler and "Mac" MacKellar. On July 1, DeLorean, at 40, was promoted to general manager of Pontiac.

.....

was delayed until a new factory had been completed and the 1966 Tempest could go on the assembly line.

During all this time, the belt tests never stopped. Early belts with steel cords corroded. Stainless steel worked well, but proved prohibitive in cost. Pontiac then settled on a fiberglass reinforcement as the tension member, and a nylon fabric impregnated with neoprene for the tooth face. A number of 50,000-mile endurance tests proved it a winning combination. The belts have now been tested over three million miles.

The engineers wondered how the belt would react to backfiring and running-on (dieseling). There was no damage, malfunction, or irregularity in timing—such as cog jumping or belt throwing—up to 6,500 r.p.m. The belt never slipped over a cog unless loaded in excess of 1,000 pounds (maximum load when fitted in the engine is 333 pounds). Under direct tension, the belt withstood 2,950 pounds. It kept well aligned on the pulleys, and there was no sprocket-wear problem during abrasion tests after a switch was made from aluminum to hardened cast-iron sprockets.

Through oven and ozone. The belt passed both oven and ozone aging tests with flying colors. There were no irregularities after a simulated five years of ozone aging. Oven tests on a 200-hour cycle began at 230 degrees F., were repeated at 250 degrees, and were followed finally by 1,000 hours at 300 degrees. The outside cracked, but the inside did not even stretch. The belt was put back on an engine, which ran with faultless timing.

Despite the low frequency of maintenance, Pontiac gave a lot of attention to engine accessibility. The engineers combined distributor, oil pump, and fuel pump in one detachable assembly, driven from a third sprocket in the belt loop. Belt tension on the prototype engines could be adjusted by sliding the accessory assembly up and down a ramp on the block. Tests indicated that there would be no need for service adjustment, so the setscrew arrangement was scrapped. The belt is tightened to specified tension during assembly at the factory and is expected to run in the same tension for life.

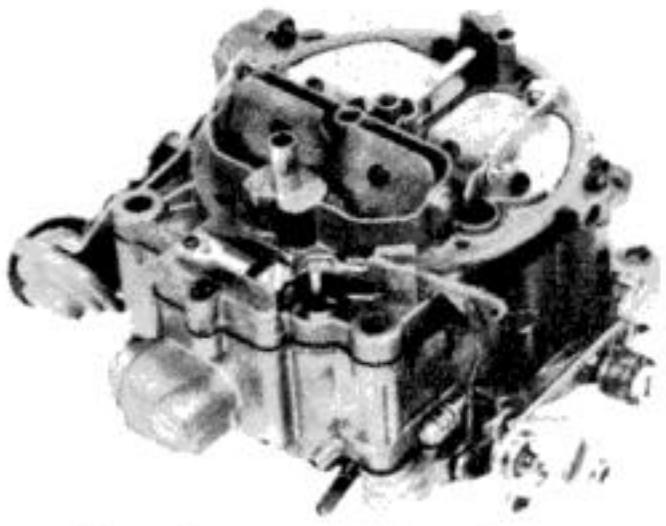
Tackling the tappets. With a noiseless camshaft drive, tappet noise became the next obstacle. Pontiac wanted hydraulic zero-lash adjustment—something that had never been tried in connection with overhead camshafts. They promptly designed a system with finger followers pivoted on zero-lash adjusters (which resemble the hydraulic valve lifters commonly used in pushrod engines). The system not only reduced noise regardless of operating temperature, but also reduced wear on the valve-gear parts.

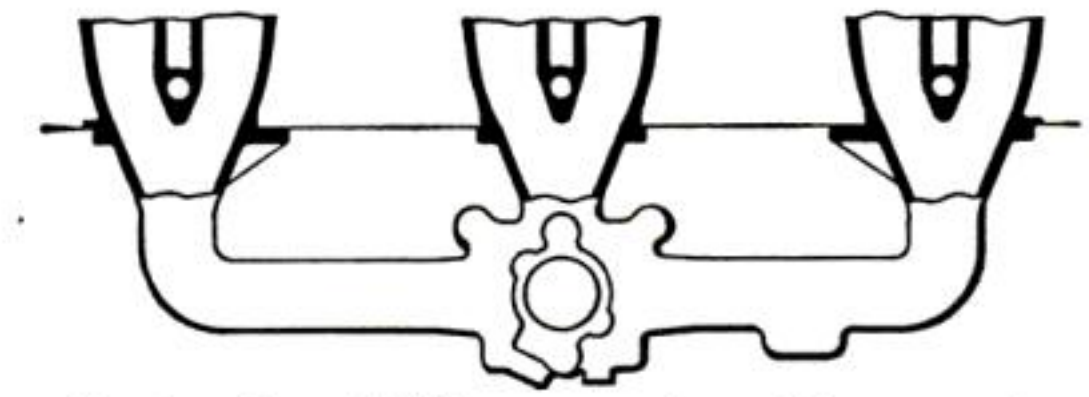
Valve lash is made up of the clearance between all parts in the valve train. With zero lash, the engineers avoid design compromises to assure ease of tappet adjustment, and it enables them to choose cam contours that will improve coordination of intake-valve opening and exhaust-valve closing, which in turn raises compression. There's no need for cam ramps when there's no lash, so the valves can be opened quicker. Cams can also be de-

Urheberrechtlich geschütztes Material

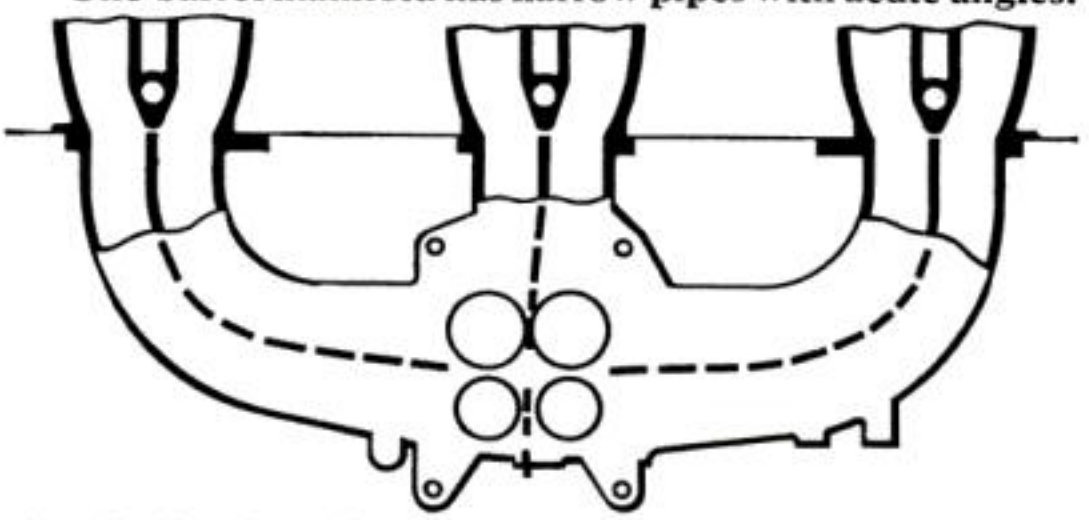
High-performance model has four-barrel Quadra-Jet carb

Compression, camming, and carburetion distinguish the hot new six from the regular-fuel version. The four-barrel carburetor chosen for the 230 Tempest is Rochester's new Quadra-Jet with the same throat sizes as Chevrolet's 396-cu.-in. V-8. It has just one float chamber for all four barrels.





One-barrel manifold has narrow pipes with acute angles.



Four-barrel manifold has large pipes to all cylinders but the pipes fail to provide equal distance.

signed to allow lower valve-seating velocities.

Just as in hydraulic valve lifters, the adjusters automatically compensate for heat expansion by a slight predetermined leak from the pressure chamber. To maintain zero lash on the next cycle, a ball check valve opens to admit more fluid.

Finger followers (similar to those used by Mercedes-Benz on OHC engines) were chosen as the best way to combine an overhead camshaft with hydraulic adjusters. They have low friction and impose no bending loads on the valve stems.

The finished design gave a 61-percent reduction in the weight of reciprocating valve-train parts compared with the old six, and with such low-inertia loads, the engine will not only reach higher rotational speeds but will reach them quicker. Both engine weight and manufacturing costs were cut by locating the camshaft bearings in the die-cast aluminum cover instead of in the cast-iron cylinder head. The camshaft has hollow flanks for the sake of lightness.

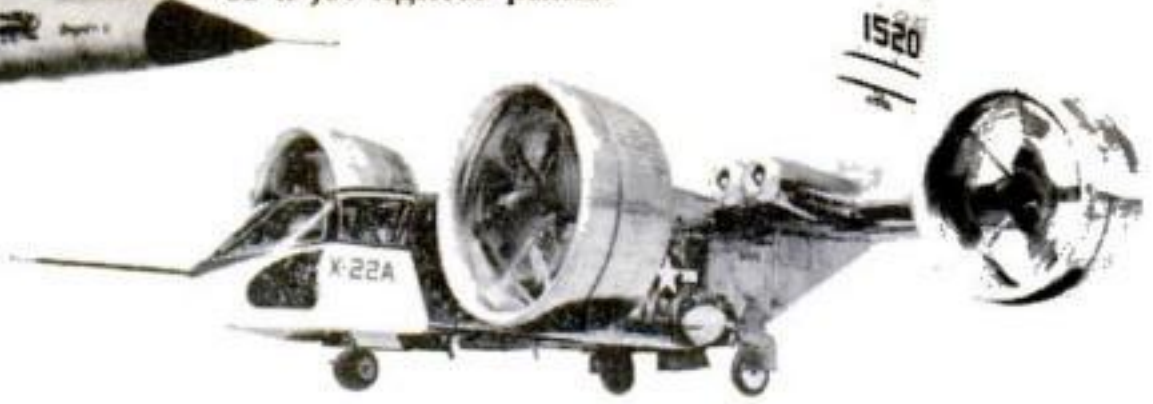
Combustion-chamber shape can make or mar engine performance. The only other OHC six currently built in the U.S. is the Kaiser Jeep with "spheroidal" combustion chambers. Pontiac prefers wedge-type heads with a 12-degree slant on the valves, and the new six has cylinder heads closely patterned on the 389 cu.-in. V-8 with contour-machined chambers. Intake-valve head diameter is identical with the big V-8 at 1.92 inches. The main advantage of the wedge-type chamber is that the end gas (detonation-prone gas left over from the last combustion) is kept in a high-turbulence area at the opposite end from the spark plug, where the excess heat is absorbed by the block and head before detonation can occur. Hemiheads may be more efficient for ultra-high performance, but for all-around use Pontiac believes the wedge-type head is superior.

A new stiff crankshaft with seven main bearings assures sustained high-r.p.m. reliability. For extra robustness, the cylinder block extends well below the crankshaft center line (the pushrod-six block ended on the center line).

The next step? Overhead camshafts for the Pontiac V-8s, of course. Both chain-drive and belt-drive versions are already on test. Rolls-Royce maintains that gear drive can be made quieter than chains, and Pontiac is probably exploring that avenue, too. But I think the future lies with belts. ■■

Urheberrechtlich geschütztes Material

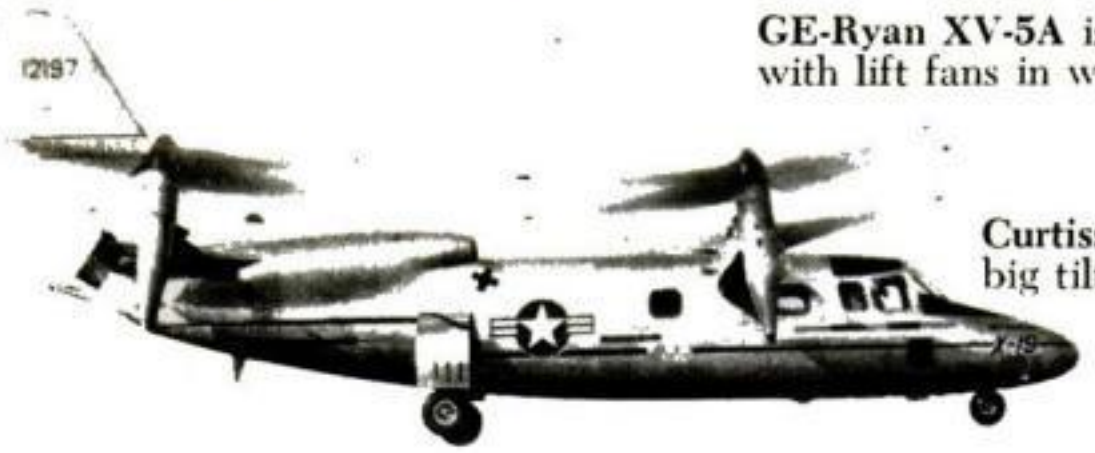
French Balzac is prototype of a jet fighter plane.



Bell X-22A, newest VTOL, has ducted props that tilt up.

Vought-Hiller-Ryan XC-142A is a tilt-wing transport.

GE-Ryan XV-5A is Army jet with lift fans in wings.



Curtiss-Wright X-19 rises on big tilting propellers.

VERTICAL-TAKEOFF PLANES: How Soon Will

The big shakedown is on, to pick the best of the competing VTOL (vertical takeoff and landing) aircraft—for military use at first, then as a go-anywhere civil transport

By Wallace Cloud

WITH its bug-eyed cockpit canopy and the wing shoved back where the tail should be, the X-22A looked like a frog, I thought as I watched the plane being rolled out for the press recently at the Bell Aerosystems plant near Niagara Falls, N.Y.

Four General Electric T-85 turboshaft engines roared, and the four pods housing ducted propellers—two at the wingtips and two mounted just aft of the cockpit—tilted slowly back until they pointed straight up, directing a blast of air downward.

The propellers were driven through a system of shafts and gearboxes from the engines clustered on the wing.

The vertical thrust built up, but power was held below that needed for lift-off. While flight-testing had officially begun,

Urheberrechtlich geschütztes Material

English Hawker Siddely P.1127 jet is one of the most successful VTOLs. Unusual photo above shows it balanced on downward-deflected jet exhaust that blurs trees in background. Blast is directed down or to rear by nozzles in side of fuselage, visible in side view at left.

You Fly in One?

West German VJ-101 has tilting wingtip jet engines.

Lockheed XV-4A hovers, can do 500 m.p.h. in forward flight.

under a tri-service contract for the Army, Navy, and Air Force, the first flight was yet to take place—away from the eyes of reporters.

Roll-out of the Bell X-22A completes the U.S. branch of the family of grasshopper planes now being tested in this country and Europe—VTOL aircraft that can fly vertically or hover like a helicopter, but behave like an airplane in forward flight. Unlike the weird-looking "flying bedstead" types of a few years ago, these VTOLs are real airplanes capable of high performance. The next step, based on the tests now going on, will be the determination of which designs will be used for operational airplanes.

Who needs VTOLs? Airlines have felt an increasing need for a small transport

CONTINUED

Urheberrechtlich geschütztes Material

Prop-driven and jet VTOLs foreshadow military transport

to fly in and out of small towns, suburban areas, and even big-city centers. Helicopters have so far proved uneconomical—and they're slow for cross-country flights. Many of the small airports scattered across the country are inadequate for any kind of commercial transport plane. VTOL transports could land anywhere in a space the size of an oversize parking lot.

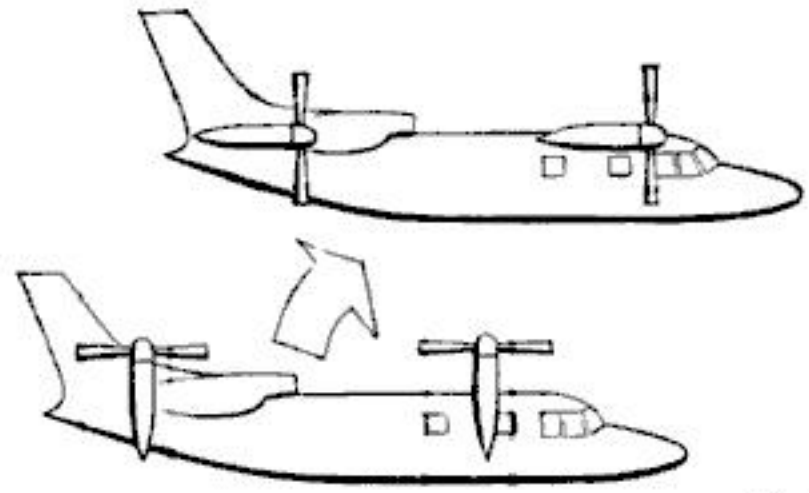
A more pressing need is military. In the fluid combat conditions of today's limited wars, landing strips take too long to build and are soon abandoned. VTOL transports and fighters could move rapidly in and out of jungle clearings, although it seems likely that quickie landing pads of some sort will be necessary.

The crash record. Talking with designers and engineers, I found that although the fatal crash of a GE-Ryan XV-5A on April 27 was fresh in everyone's mind, there was general confidence that the many problems of VTOL flight would be overcome.

The Army-sponsored XV-5A crashed during a press showing at Edwards Air Force Base, Calif. It was considered a highly promising plane—the two XV-5As flying that day had made over a hundred successful test flights. The test pilot, W. L. "Lou" Everett, was preparing for a helicopter-like landing from a height of about 800 feet, when he suddenly radioed "I've got to get out!" The plane nosed down about 35 degrees and crashed into the sun-baked dry-lake bed. Everett got out by means of his ejection seat, but the parachute didn't open, and he was killed.

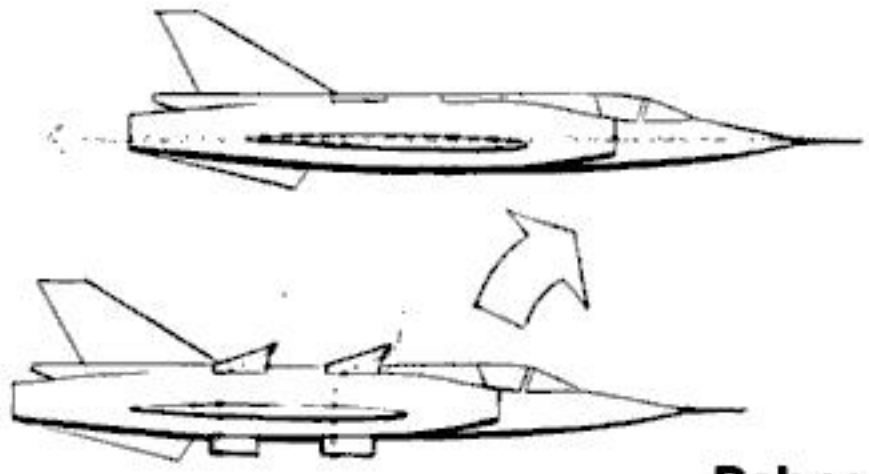
Four other current grasshopper planes—all jets—have also crashed in the last couple of years: a Lockheed XV-4A (pilot killed), a French Dassault Balzac (pilot killed), a West German VJ-101 (pilot injured), and a British Hawker Siddely P.1127 (plane slightly damaged, pilot unhurt).

While the crashes have not all had the same cause, they highlight a major problem of VTOL aircraft: lack of stability



X-19

Propeller-driven VTOLs rise like a helicopter for takeoff and landing, and props tilt forward for horizontal flight. Curtiss-Wright X-19 is simplest example. Bell X-22 has ducts around



Balzac

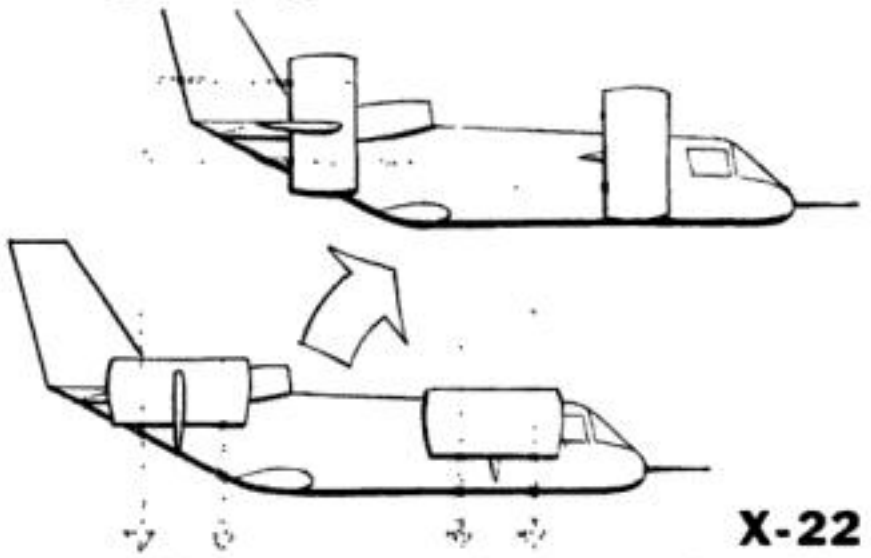
Pure-jet VTOLs use rocketlike blast of their jet engines for lift as well as forward propulsion. French Balzac has separate lift engines buried in fuselage, which are shut off in for-

in hovering and low-speed flight. A conventional airplane nearly always has some inherent stability—it wants to fly straight and level. Air moving past the wings provides lift, and interaction of the air with the rudder, elevators, and ailerons provides control. But a VTOL in hovering flight, and in transition to or from the vertical, is just a mass balanced on its supporting jets or propwash; the wings and control surfaces are not functioning. The VTOL can easily flop over and fall to the ground.

To remain balanced in the air, a VTOL must have some form of "attitude control"—positive control of the direction in which its nose points. This may be accomplished by air jets, by variable propeller pitch, or by fins and vanes that move in the supporting airstream, depending on the type of VTOL. These controls, how-

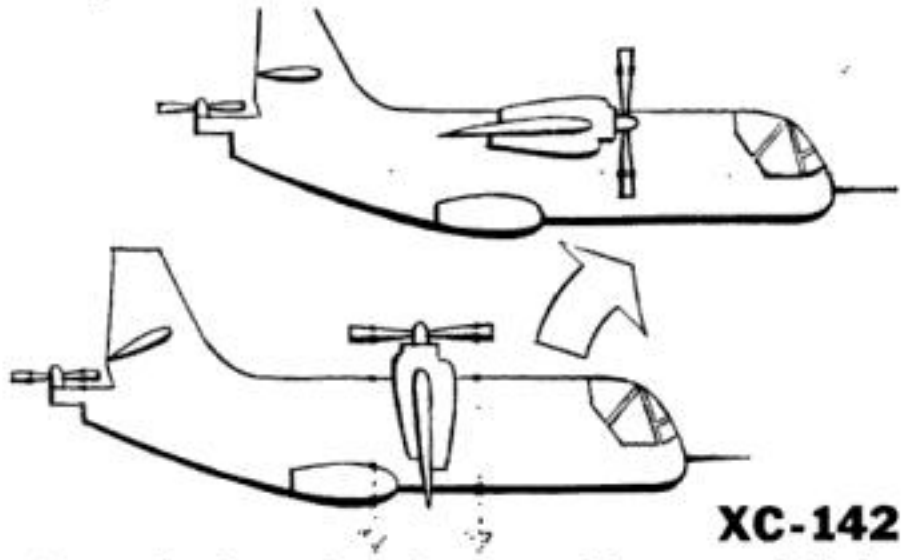
Urheberrecht ch geschütztes Mate

and fighter planes, then civil transports for feeder routes



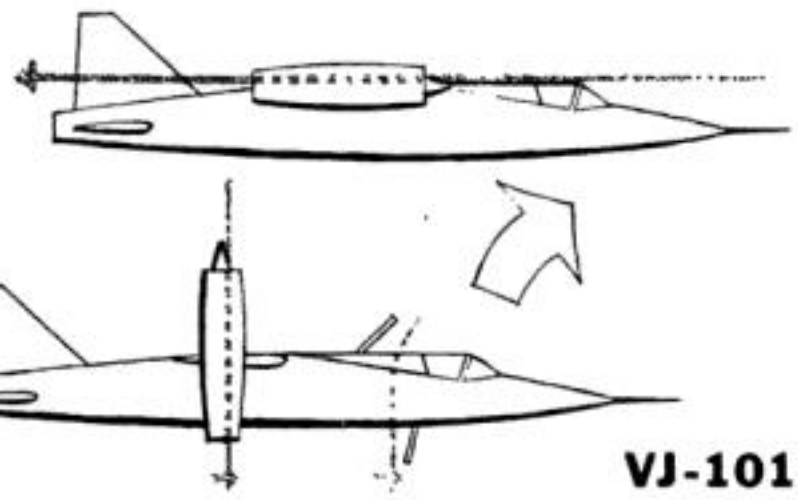
X-22

the propellers to increase thrust. Vought-Hiller-Ryan XC-142 tilts its entire wing along with props; a tail rotor controls plane's pitch in hover. Wings and control surfaces of these



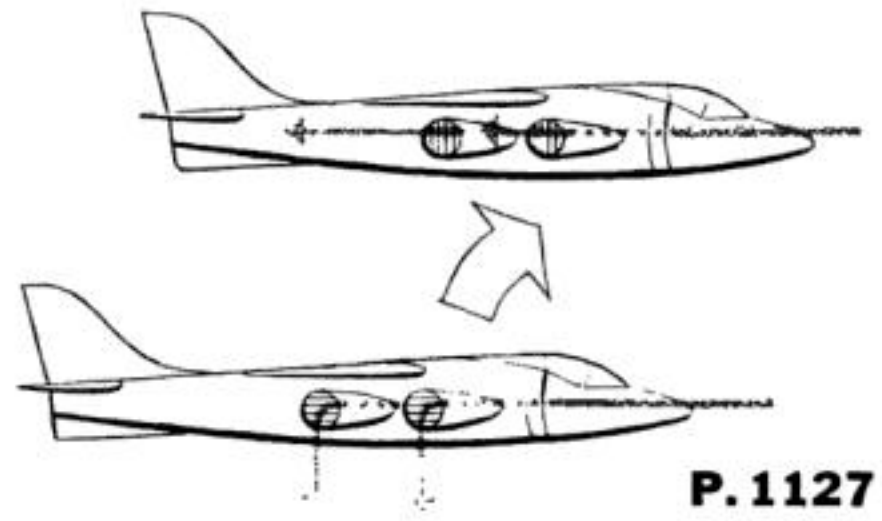
XC-142

planes don't work in hover and low-speed flight, so stability is controlled by tilting and changing pitch of the propellers separately, and by flaps extending into the slipstream.



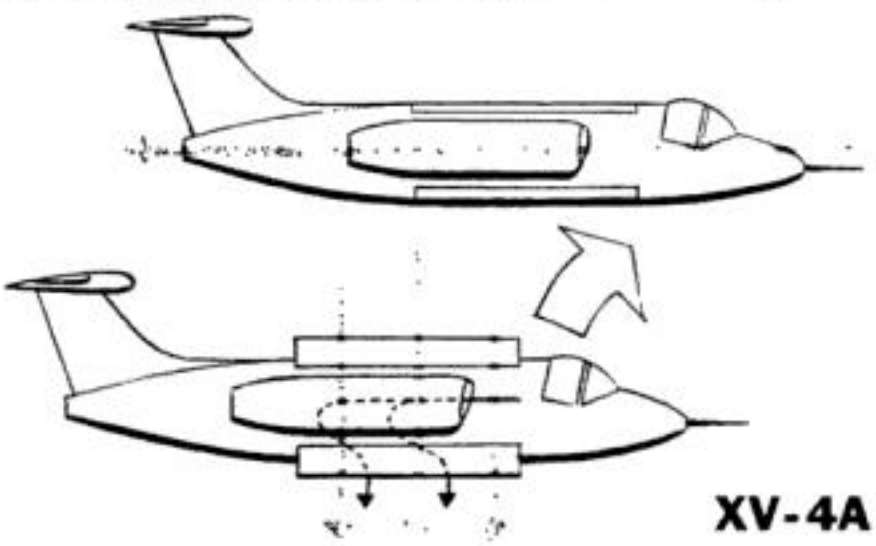
VJ-101

ward flight. German VJ-101 has tilting lift-cruise engines on wingtips as well as lift jets in fuselage. British Hawker Siddely P.1127 uses same engine for lift and propulsion, with



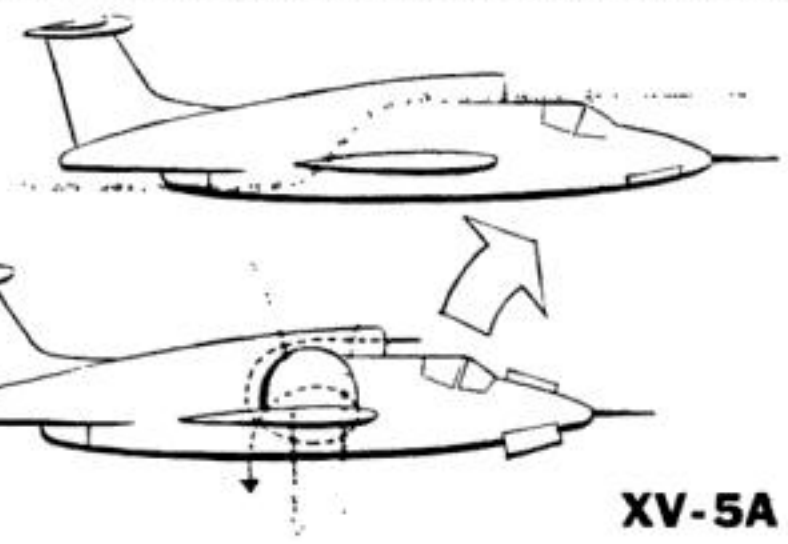
P.1127

louvered deflectors in side of fuselage that rotate to direct exhaust down or to rear. Air jets in nose, tail, and wings control stability of planes while they are in hovering flight.



XV-4A

Composite-jet VTOLs use jet engines for forward flight, but utilize diverted exhaust from the same engines in a different kind of system for lift. Lockheed XV-4A feeds exhaust from



XV-5A

jets into ducts within fuselage, sucking air in from above to increase the total flow that is pushed out below. GE-Ryan XV-5A uses jet exhaust to spin lift fans in wings and nose.

ever, must work automatically in order to compensate instantly for unbalancing conditions such as gusts of wind. A human pilot can't react rapidly enough.

Vertical vs. horizontal. Another major problem, the one that's responsible for the diversity of VTOL types being tested today, is the contradiction between engine requirements for lifting flight and horizontal flight. Thrust, for both lift and forward propulsion, can be obtained by moving a large mass of air at relatively low velocity by means

[*Continued on page 176*]

Urheberrechtlich geschütztes Material

JEEP is the lightest car by far in this group. Finish and trim: stark but generally adequate.

NISSAN PATROL is the heaviest and most powerful, with a six-cylinder 135-hp. engine.

Test-Driving the RUGGEDS ...on and off the road

Urheberrechtlich geschütztes Material

LAND-ROVER is a high-quality universal car and may in fact be the most rugged of all.

SCOUT proved second to no other rugged in the rough, yet has a good ride on smooth roads.

Who needs roads? Hop aboard a Jeep, Scout, Patrol, or Land-Rover and find out why we call them the "ruggeds"

By Jan P. Norbye. Exclusive Photos by Bill Morris

MORE and more people are discovering exciting places to go that used to be inaccessible to motorists. These modern explorers travel in rugged cars with four-wheel drive, and nothing short of an earthquake or a major flood can stop them. The "ruggeds" can go up and down mountains, and across fields, rivers, and deserts—road or no road. They

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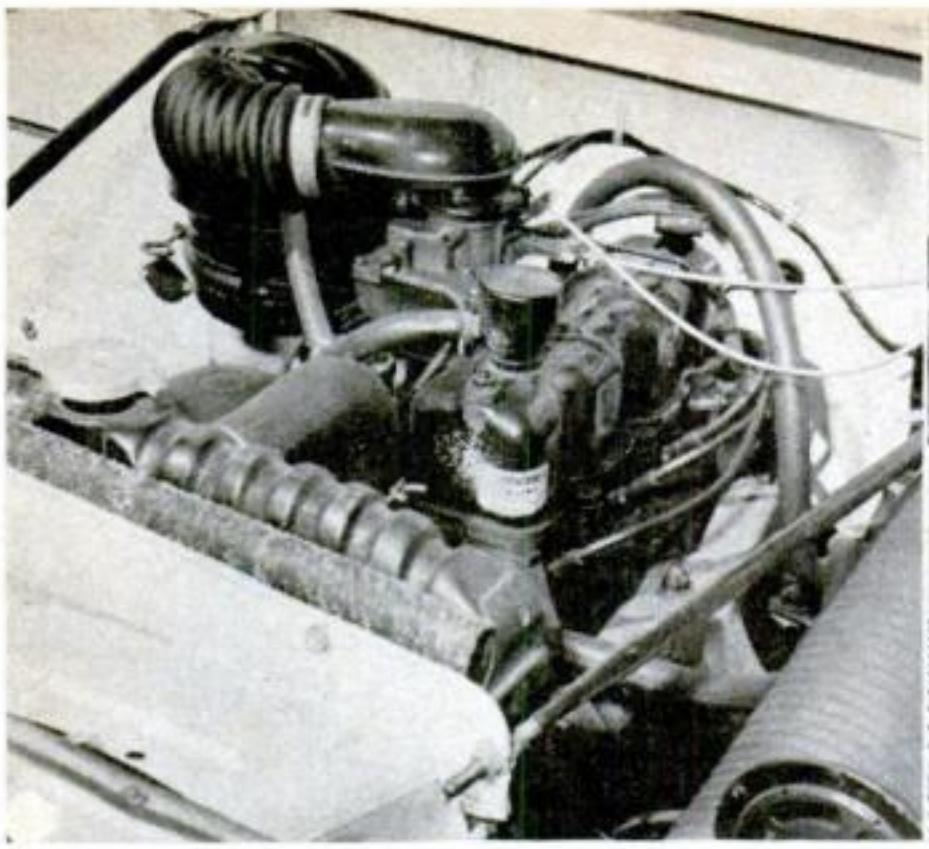
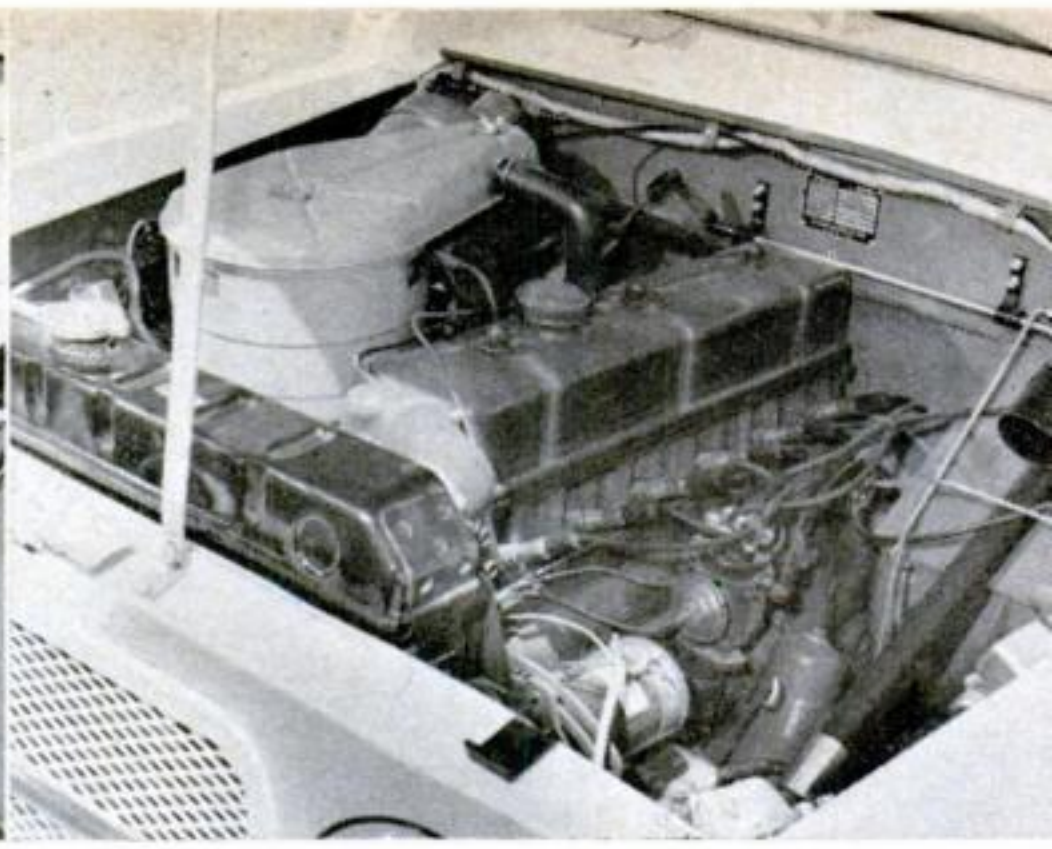
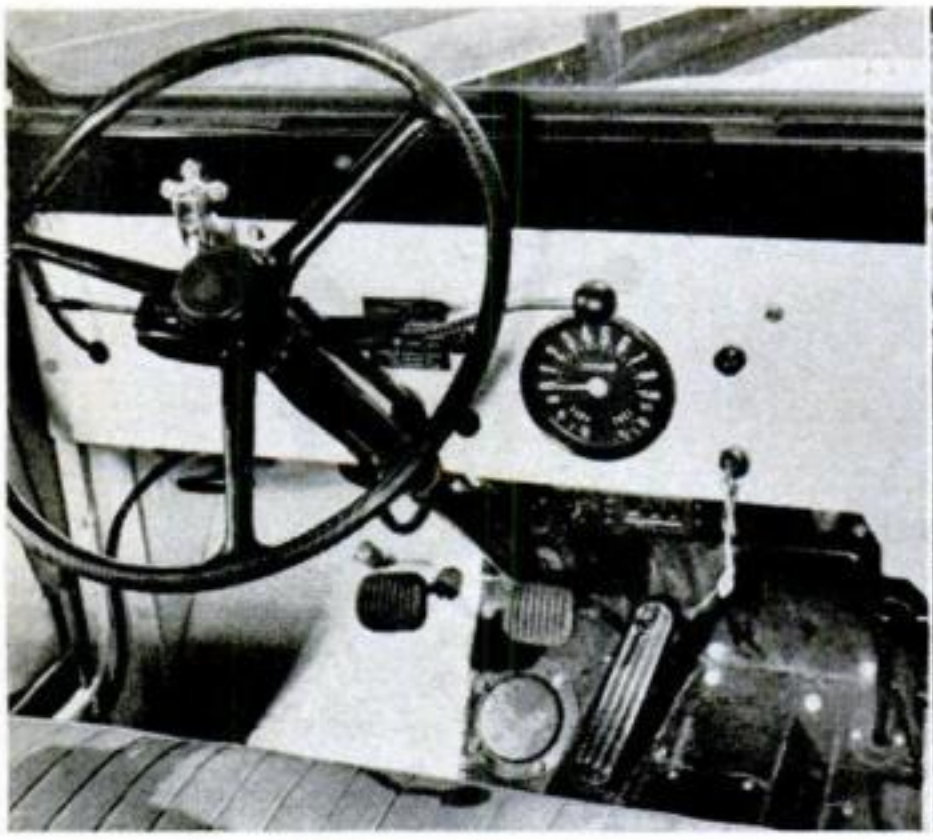
Urheberrechtlich geschütztes Material



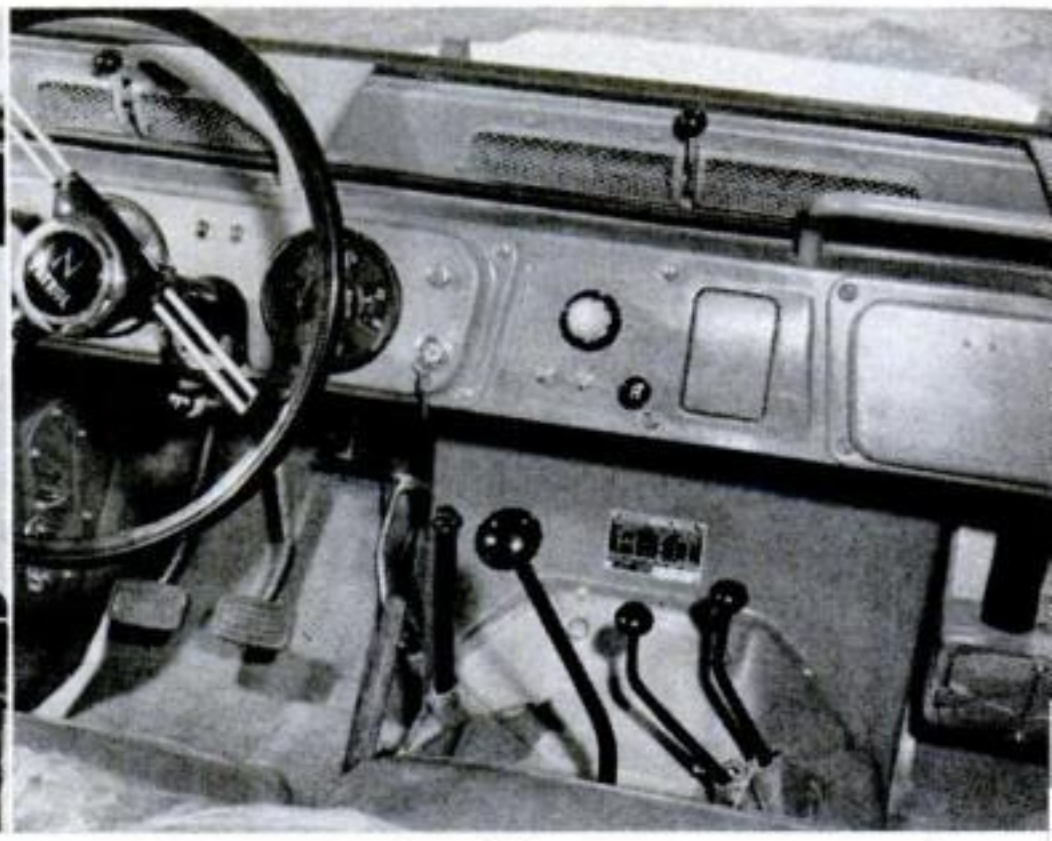
JEEP has 75-hp. F-head engine (overhead intake, side exhaust valves) which peaks at 4,000 r.p.m. It sounds very noisy at speeds over 50.



NISSAN PATROL has screwed-on plug leads and is well waterproofed. Overhead-valve in-line six offers excellent accessibility for repair.



JEEP instruments and controls are simple and straightforward. One handle gives all combinations of transfer case and four-wheel drive.



NISSAN PATROL has full instrumentation and well-placed controls. The ride is softer than the Land-Rover's, harder than the Scout's.

don't bog down in mud and sand, get stuck in snow, skid on ice, or stop if water rises above their knees. They have ground clearances that don't need ballroom-floor road surfaces, and their undersides are almost invulnerable.

Although many of us think of the "four-by-four General Purpose" in primarily military terms, these vehicles have important civilian uses in forestry, on farms, by sportsmen and adventurers, and by just about everybody on the outposts of our civilization.

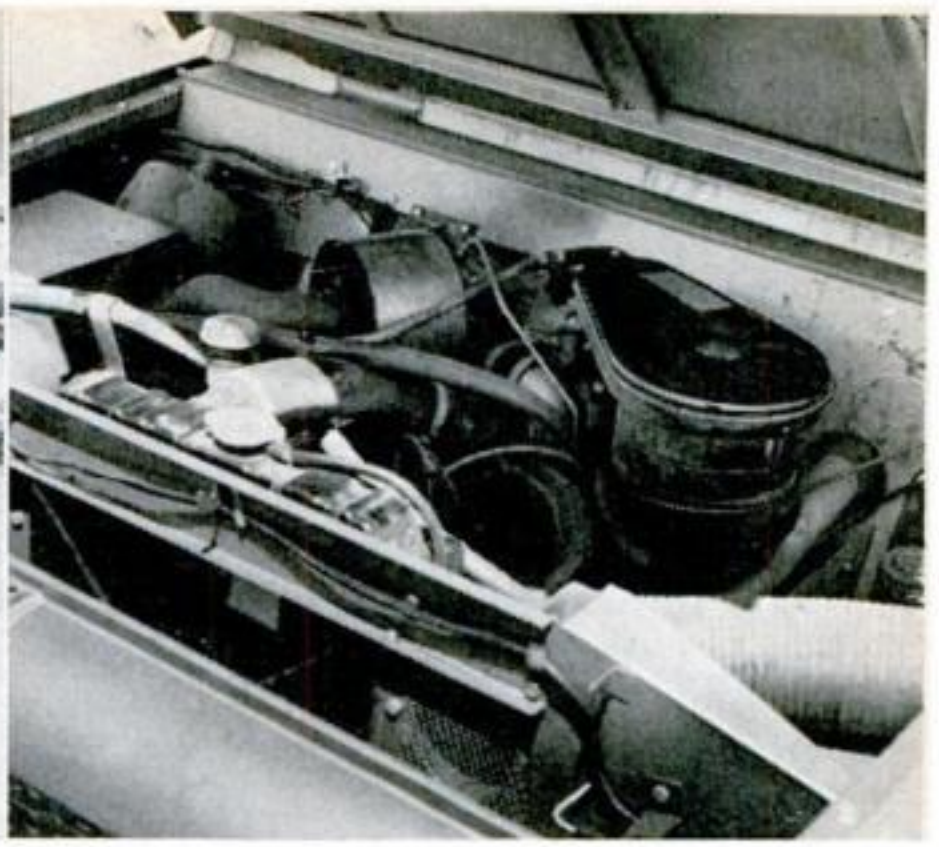
Because of their mechanical complexity and relatively low-volume production, the ruggeds don't come cheap. Prices start at around $2,250, and special equipment—power take-offs, winches, towing attachments—plus the usual choice of sunroofs, luggage racks, and radios can easily push the price above $5,000.

Willys (now Kaiser) knew a good thing when they started building the Jeep, and the company has based its commercial stability on the strength of the famous vehicle. Proof of the pudding is the many successful imitators of the Jeep.

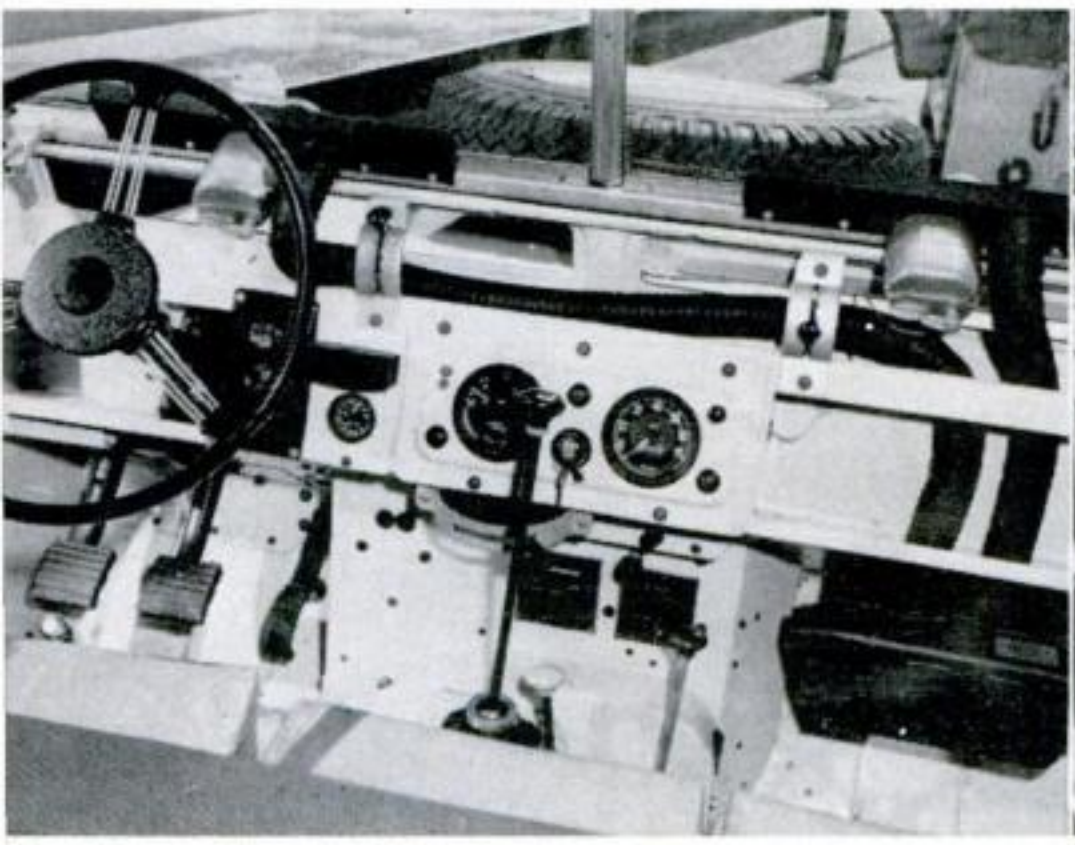
Among the ruggeds, perhaps the best

Urheberrechtlich geschütztes Material

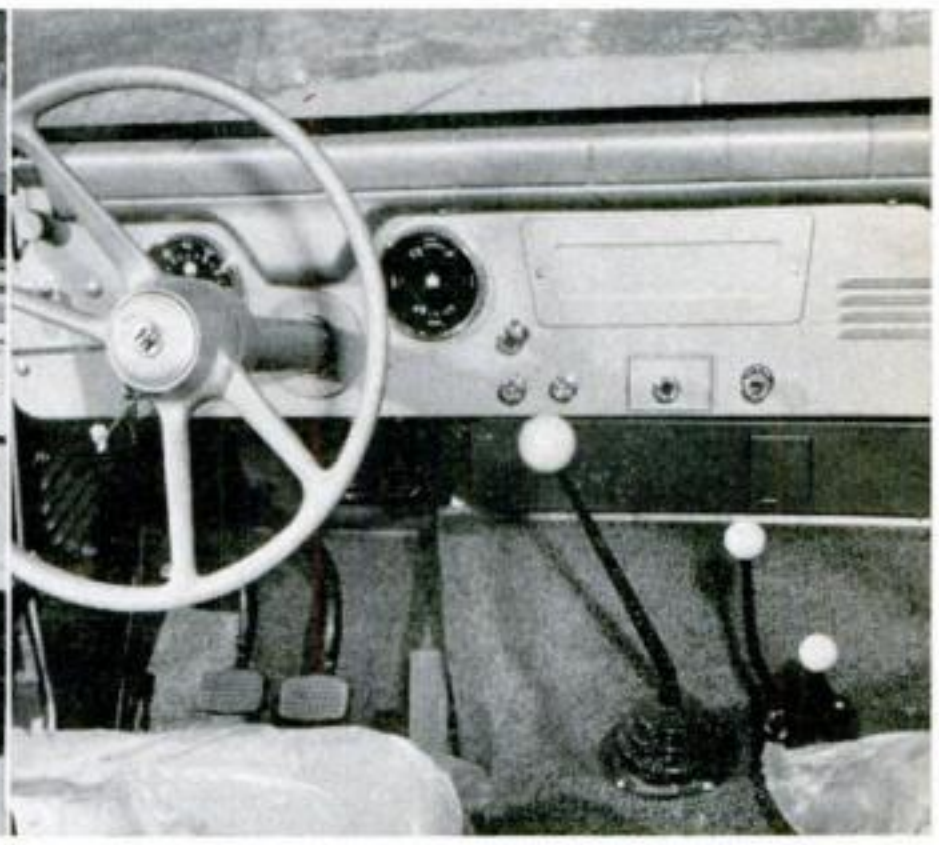
LAND-ROVER engine is a conventional OHV four of 77 hp. It revs to 5,000, runs smoothly, but low gearing makes it sound too busy.



SCOUT has new OHV four with turbocharger. Torque is poor in low range, excellent at high r.p.m. Top speed handsomely exceeds 80 m.p.h.



LAND-ROVER has cramped foot room and inconvenient controls. Starter button is hidden under dash, and the hand-brake lever lies on the floor.



SCOUT has inadequate instruments but offers almost passenger-car accommodation. View from driver's seat is excellent. Controls are well placed.

known, besides the Jeep, are the International Harvester Scout, the British Land-Rover, and the Japanese Nissan Patrol.

The Scout proved surprisingly versatile in my tests. In the rough, it does everything the Land-Rover, Patrol, and Jeep do. On the highway, it has a much better ride. It's the only rugged with a face-forward rear seat (the others have benches along the sides, passengers facing each other), but it's a four-seater while the others seat six. Luxury is a dirty word to the makers of Jeeps, Land-Rovers, and Patrols. The Scout, on the other hand, stands alone in having such civilized touches as a cigarette lighter.

At the other extreme is the Jeep Tuxedo Park, with its 81-inch wheelbase and a ride so bumpy you'd swear you were traveling on railroad ties. The Land-Rover rates second in this regard, and the Nissan has an even softer ride than the Land-Rover, but on high-speed turns the body rolls considerably. The Land-Rover corners bolt upright and handles with utmost precision. The Scout, with a lower center of gravity than its rivals, easily outhandles them all at speed.

Ford and American Motors build mili-

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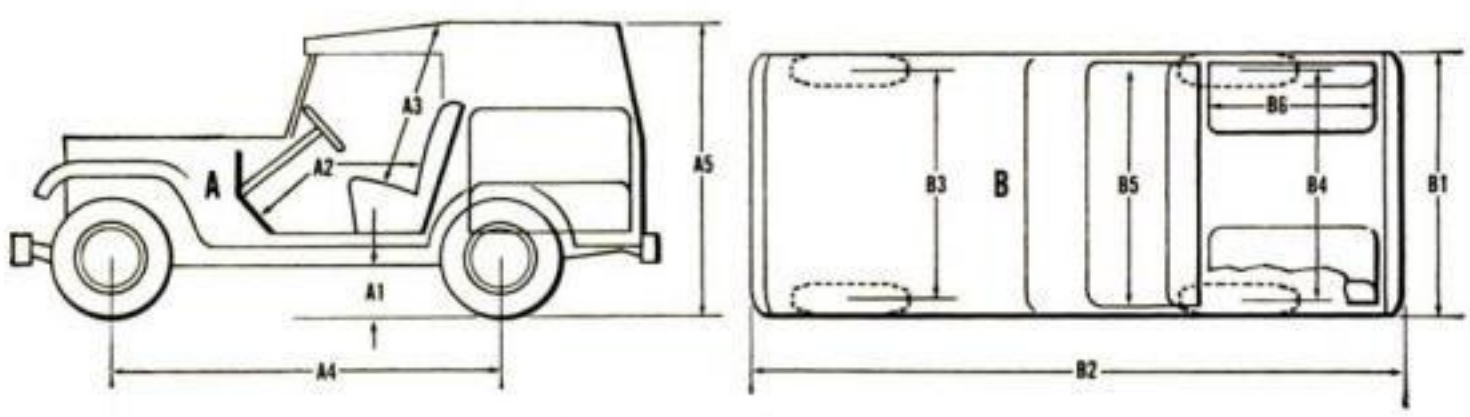
Urheberrechtlich geschütztes Material

Our four ruggeds brought only one surprise: the amazing versatility of the International Scout.

tary ruggeds with all-independent suspension, but "civvy" models of all popular makes have rigid front and rear axles with semi-elliptic leaf springs. Such engineering may not make for the best ride and handling for those of us not in khaki, but it cuts manufacturing costs and practically guarantees trouble-free motoring.

Power units. I loved the six-cylinder engine in the Patrol; the other cars have four-cylinder engines. The Scout, however, was fitted with a $280 optional turbo-

[Continued on page 172]



	INTERNATIONAL Scout	KAISER JEEP Tuxedo Park	LAND-ROVER	NISSAN Patrol
DIMENSIONS (inches)				
A1 Ground clearance	9.125	8.5	7.5	9.25
A2 Front legroom	41.5	40.5	39.7	42.5
A3 Front headroom	40.0	37.0	39.0	38.0
A4 Wheelbase	100.0	81.0	88.0	86.6
A5 Overall height	68.0	71.0	77.5	78.0
B1 Overall width	78.0	71.5	66.0	66.5
B2 Overall length	164.0	137.0	142.5	148.5
B3 Front tread	53.5	48.4	51.5	54.4
B4 Rear tread	53.5	48.4	51.5	55.1
B5 Front seat width	20.0 (2)	50.0	53.5	50.0
B6 Rear seat width	37.5	32.0	31.5	36.0
SPECIFICATIONS				
Engine type	4-in-line	4-in-line	4-in-line	6-in-line
Bore & stroke	3.875 x 3.218	3.125 x 4.375	3.526 x 3.50	3.375 x 4.50
Displacement	151.8 cu. in.	134.2 cu. in.	139.5 cu. in.	242 cu. in
Compression ratio	8.19:1	7.4:1	7.0:1	7.0:1
Carburetion	1 1-bbl. + turbo	1 1-bbl.	1 1-bbl.	1 1-bbl.
Fuel grade	Regular	Regular	Regular	Regular
Fuel-tank capacity	11.0 gal.	10.5 gal.	10.0 gal.	13.2 gal.
Horsepower	111.3 @ 4,000	75 @ 4,000	77 @ 4,250	135 @ 3,400
Torque (lb./ft.)	166.5 @ 3,200	114 @ 2,000	124 @ 2,500	225 @ 2,000
Transmission	3-speed gearbox, 2-speed transfer case, four-wheel drive	3-speed gearbox, 2-speed transfer case, four-wheel drive	4-speed gearbox, 2-speed transfer case, four-wheel drive	3-speed gearbox, 2-speed transfer case, four-wheel drive
Axle ratio	3.73:1	4.27:1	4.70:1	4.10:1
Tire size	8.45 x 15	8.45 x 15	7.10 x 15	7.00 x 16
Steering ratio	29.0:1	17.9:1	15.6-23.8:1	23.6:1
Steering turns, lock to lock	5⅛	4½	4⅛	4⅛
Turning-circle diameter	41 ft., 8 in.	36 ft.	39 ft.	37 ft., 4 in.
Brakes—swept area	224 sq. in.	262 sq. in.	188 sq. in.	287 sq. in.
Curb weight	3,060 lb.	2,274 lb.	2,953 lb.	3,392 lb.
Price (as tested)	$3,276.23	$2,847.90	$2,985.20	$3,125.20
PERFORMANCE				
0-60 m.p.h.	13.2 sec.	24.0 sec.	28.4 sec.	11.0 sec.
0-80 m.p.h.	36.0	—	—	36.0
40-60 m.p.h.	9.0	15.2	18.0	9.2
50-70 m.p.h.	10.5	—	—	11.3
SS ¼-mile	21.2	23.4	27.7	20.8
Overall fuel mileage	14.8 m.p.g.	16.5 m.p.g.	14.4 m.p.g.	13.2 m.p.g.

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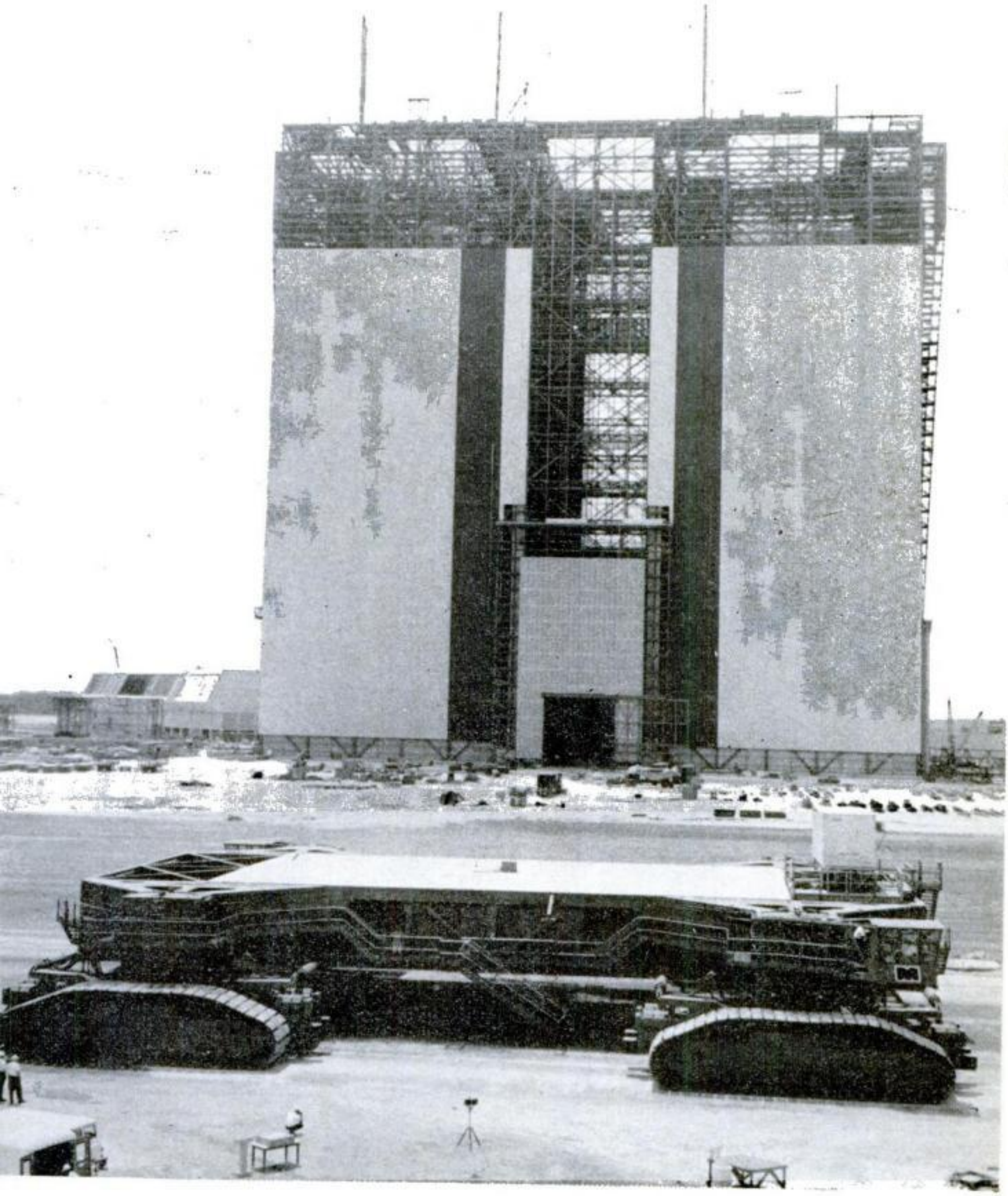
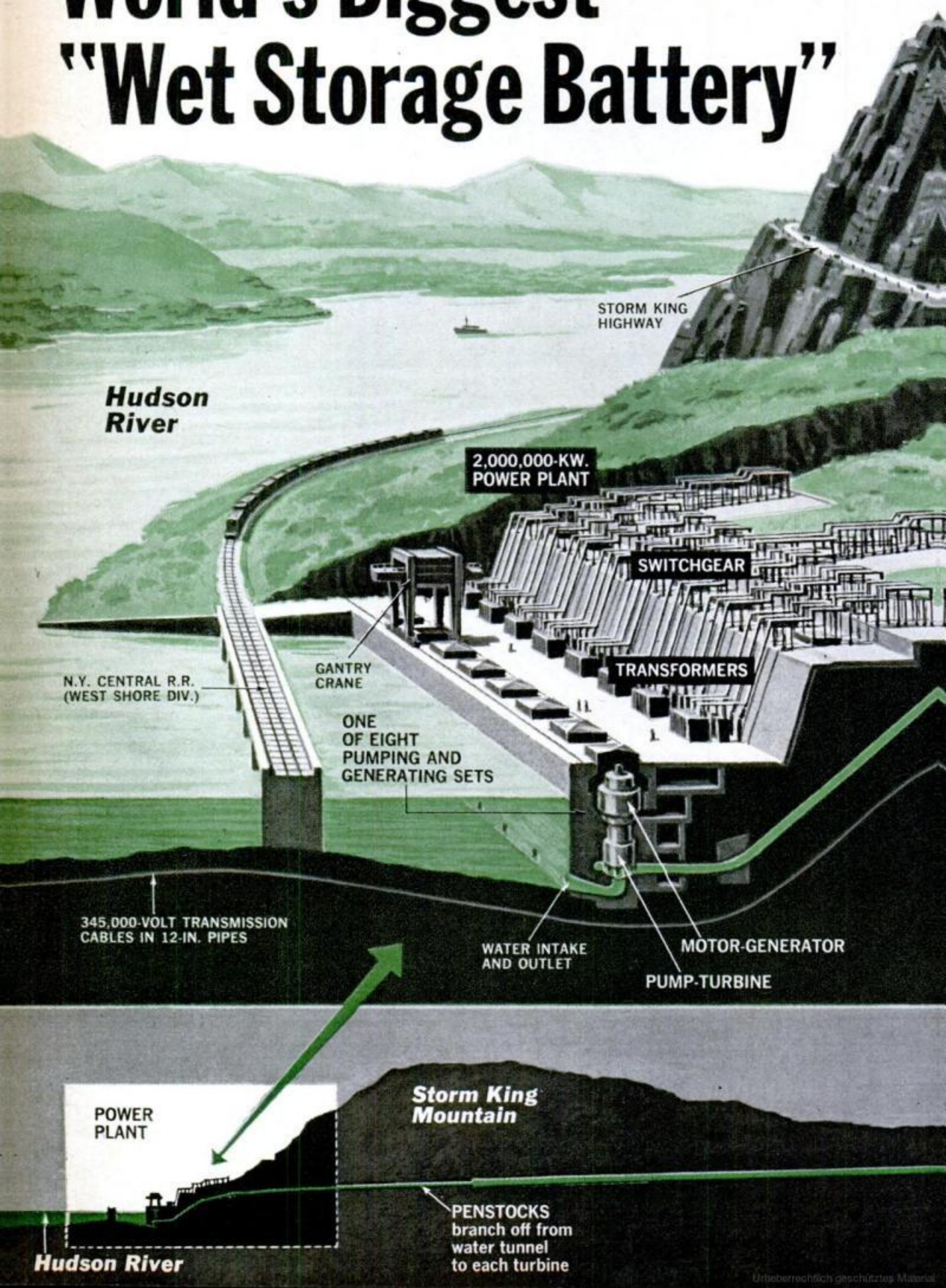


Monster crawler to move Saturn V to launch site

Aboard this huge crawler, the 350-foot-tall Saturn V with its Apollo moon spacecraft at its nose will move from its 48-story-high vertical assembly building in the background to its Cape Kennedy launch site three miles away. Two 40-foot-long diesel-electric tractors, resembling outsize Army tanks, at each corner will propel it at two m.p.h. Sixteen hydraulic jacks will keep the Saturn erect.

Urheberrechtlich geschütztes Material

World's Biggest "Wet Storage Battery"



Urheberrechtlich geschütztes Material

Up-and-down waterfall to generate two million kilowatts of electric power

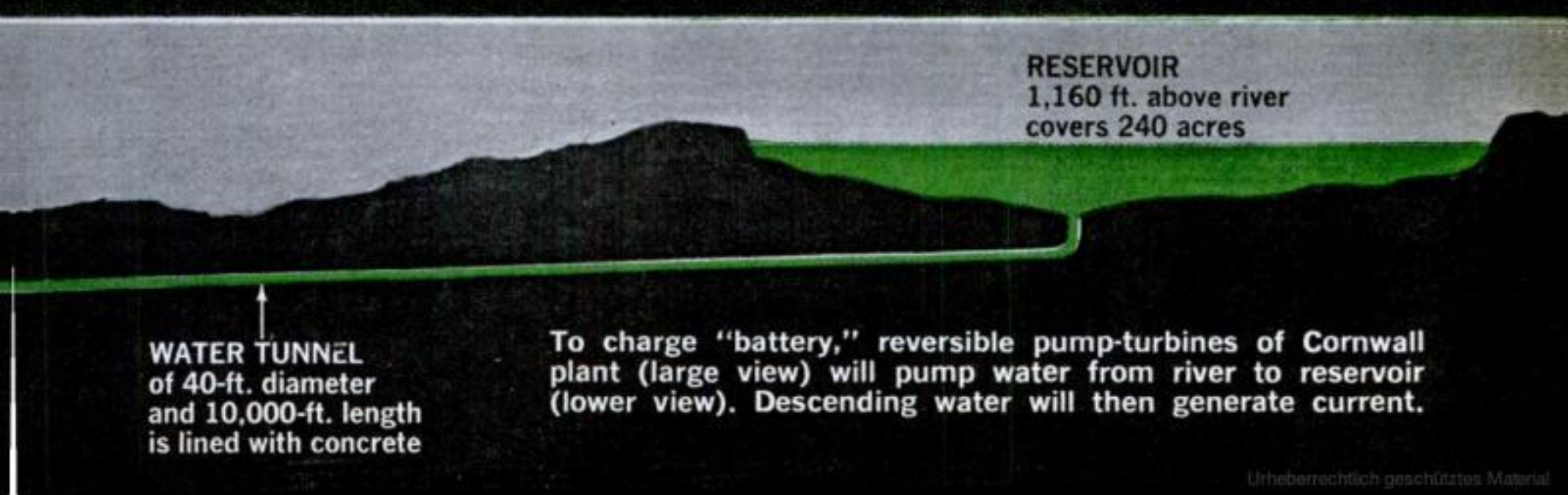
THROUGH a tunnel bigger than a vehicular tube, at Cornwall, N. Y., electric pumps will lift water 1,160 feet from the Hudson River to a mountain-top reservoir. Then the water will cascade back down—and the pumps will turn into turbines, to yield two million kilowatts of power. The $162-million "pumped storage" project, when completed in the late sixties by the Consolidated Edison Company, will be the largest in the world.

Why pump water uphill and let it run down again? You get back only two-thirds of the power you put in—but you get it when you want it.

Electricity, in city-size amounts, can't be stored. It has to come fresh from generators. And demand for juice fluctuates around the clock. Build enough conventional power plants for a city's peak needs, and some will stand idle in "off-peak" hours. The answer is pumped storage—made feasible by the introduction of reversible pump-turbines in the mid-fifties, and already applied in installations ranging up to one of 900,000 kilowatts in Luxembourg.

Con Ed's plant on the Hudson will act like a gigantic storage battery. All night, spare current from New York's steam power plants will flow to Cornwall and pump water aloft. In the morning, releasing the water will drive turbines and send current back. Pumping over weekends will make up for any excess of outflow over inflow on weekdays.

Power will flow between Cornwall and New York in 345,000-volt transmission lines, and will cross the Hudson in the first extra-high-voltage submarine cables to span a major river.—*Harry Walton.*

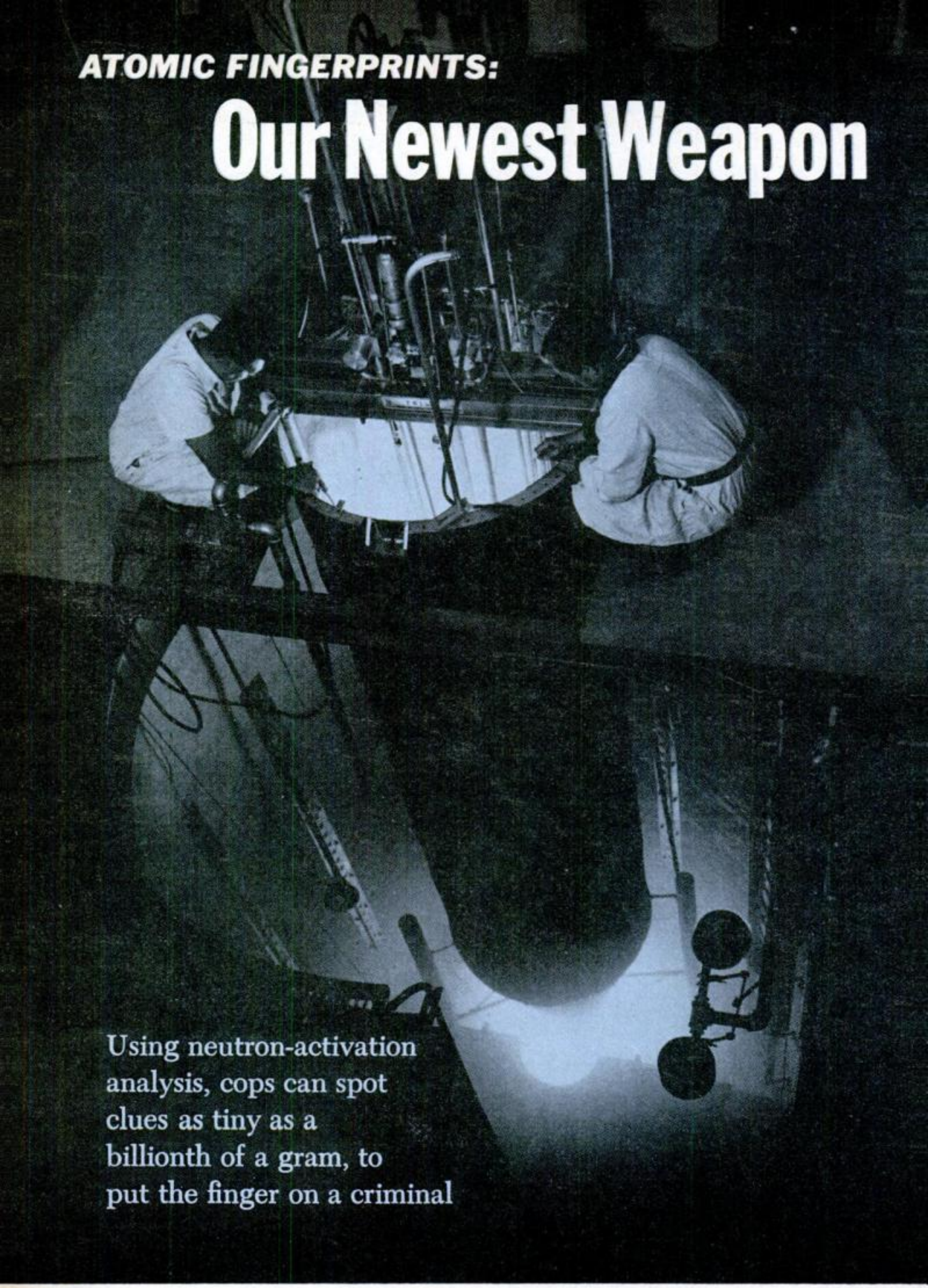


To charge "battery," reversible pump-turbines of Cornwall plant (large view) will pump water from river to reservoir (lower view). Descending water will then generate current.

Urheberrechtlich geschütztes Material

ATOMIC FINGERPRINTS:

Our Newest Weapon



Using neutron-activation analysis, cops can spot clues as tiny as a billionth of a gram, to put the finger on a criminal

Urheberrechtlich geschütztes Material

in the War on Crime

By Wesley S. Griswold

SHORTLY before one o'clock on a fine summer night last year, a silent burglar alarm suddenly flashed in a California sheriff's office.

At that moment, a patrol car was cruising within a few blocks of the liquor store from which the alarm had come. Alerted by radio, it sped to the scene and wheeled into a dark parking lot. There, blinking in the glare of the headlights, stood a man, empty-handed, making no attempt to run.

The officers discovered that the back door of the liquor store had been pried open, evidently with a heavy tool. The suspect's car, parked nearby, was lacking a jack handle. It had been lost long ago, the suspect declared. He insisted that he had had nothing to do with the attempted burglary.

So began a criminal case of far greater significance than its surface features indicated. It led to one of the first court trials in history in which neutron-activation analysis (NAA)—a spectacularly effective new tool of scientific crime detection—got its man.

The morning after that would-be burglary in California, searching police found what appeared to be the missing jack handle in the tall grass behind the liquor store. Disappointingly, it carried no meaningful fingerprints.

There was, however, some crucial microscopic evidence on it. A few flecks of brown paint clung to the wedge end. The liquor-store door was brown. Moreover, in a tarry patch on the jack handle were embedded tiny bits of light blue paint. The suspect's car was light blue.

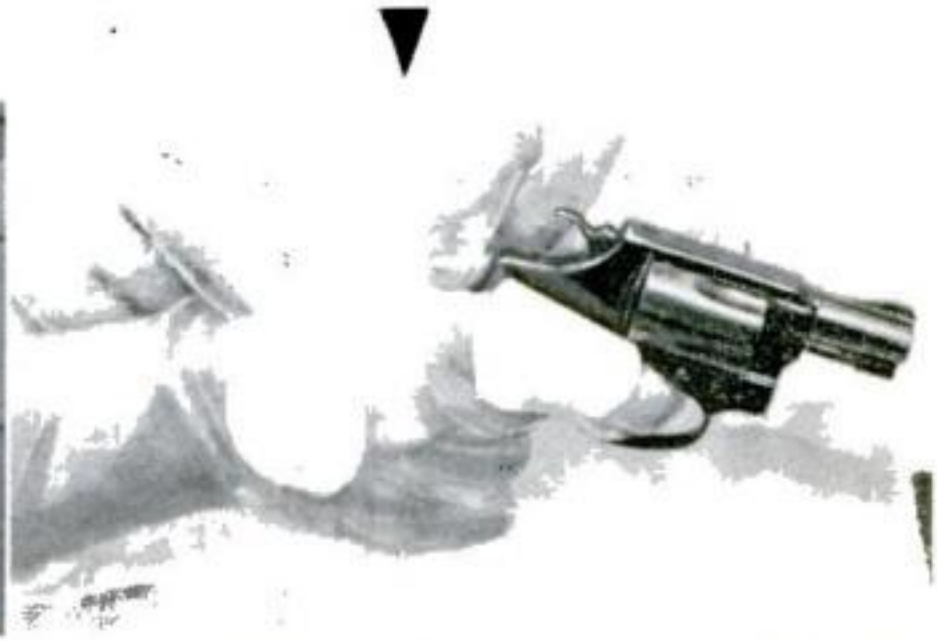
Here was impressive circumstantial evidence, but it wasn't enough to clinch the case. Jack handles like the one in question could be found by the thousands. Brown and pale blue paints were dismayingly common.

Science takes over. These bits of evidence, too small to see with the naked

CONTINUED

How activated neutrons are used to spot a killer

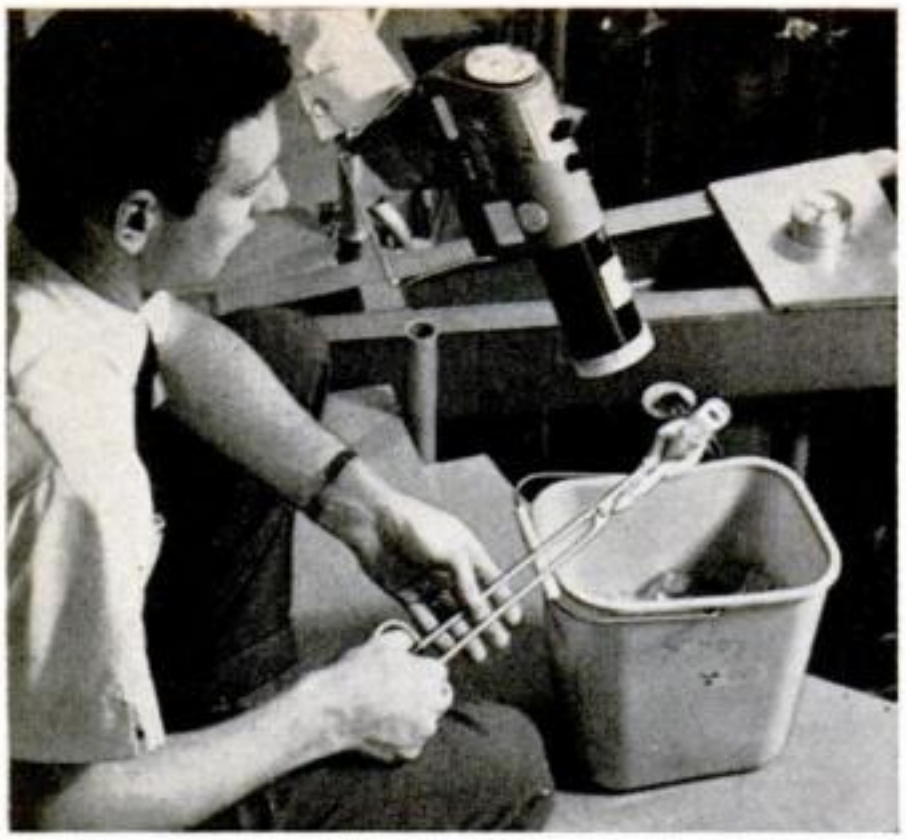
1 Dramatic advance is use of NAA to determine if a suspect has recently fired a gun. In all firings, powder dust falls on the shooter's forefinger, thumb base, and back of hand.



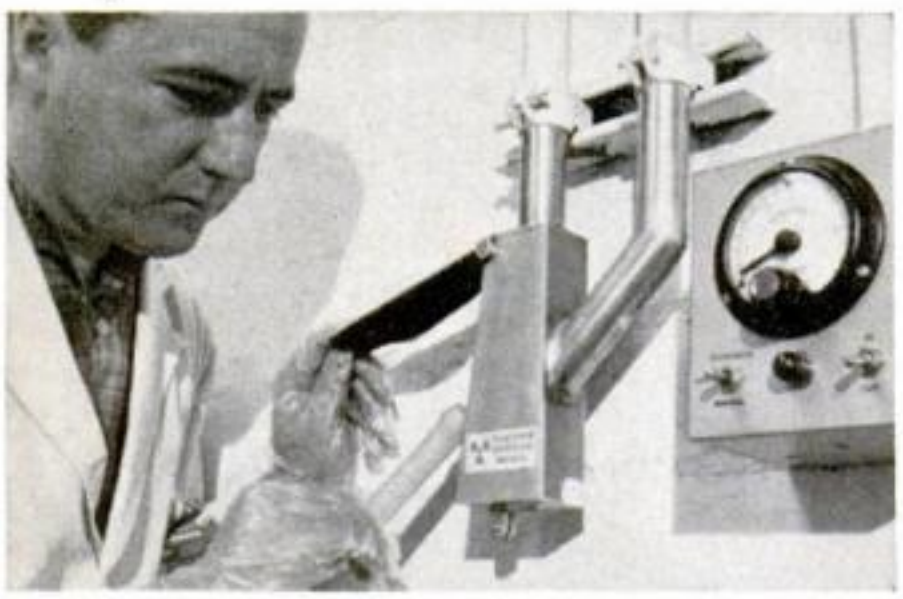
2 To test method, filter papers on plastic gloves are used to catch powder. The next step is to irradiate sample powder so that it can be analyzed with gamma-ray spectrometer.

3 Samples from pistol-firing tests are being bombarded by neutrons in the heart of General Atomic's huge research reactor, which is lit by the brilliant blue glow of nuclear reaction.

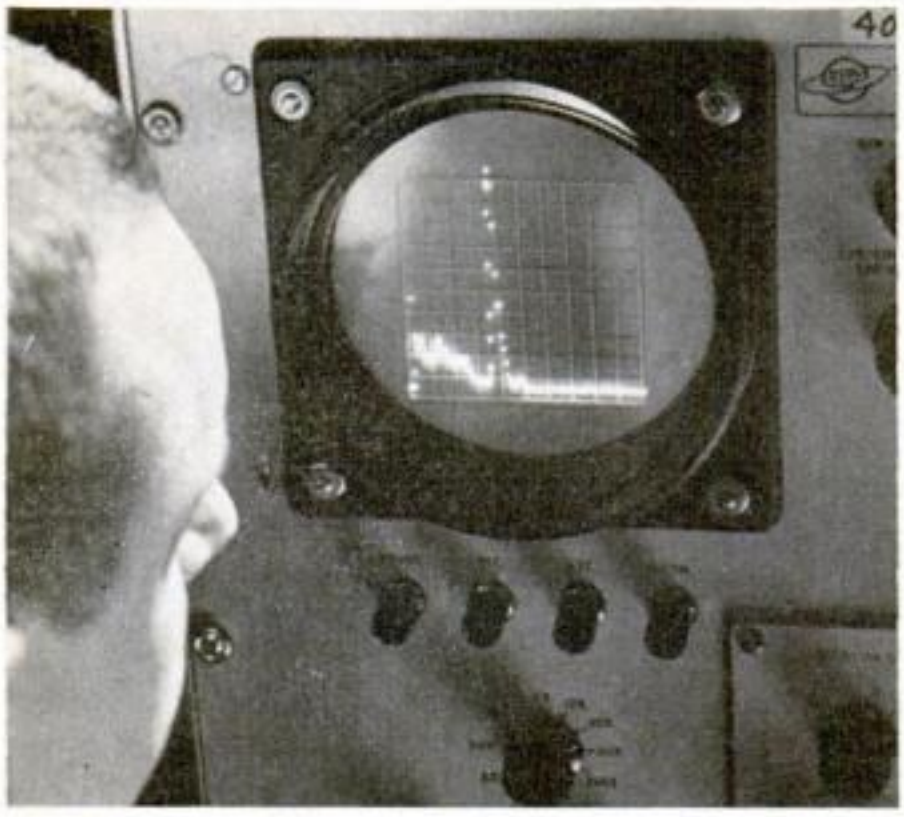
Urheberrechtlich geschütztes Material



4 Irradiated powder samples are removed from the reactor and tested for radiation intensity before being whisked to a nearby laboratory for a complete analysis of their contents.



5 Some elements in irradiated powder give off radiation so briefly they must be rushed by pneumatic tube (shown above) to lead-shielded "cave" for fast check of telltale ingredients.



6 Damning blips on oscilloscope in General Atomic's radiation counting room reveal unmistakable traces of rare elements in irradiated powder that don't show up in chemical tests.

eye, too tiny for analysis by any other method, were sent to the nuclear laboratories of General Atomic Division of General Dynamics at San Diego. There, Dr. Vincent P. Guinn and his colleagues, among the pioneers applying NAA to crime investigation in the U.S., submitted the samples to neutron bombardment in a research reactor. Using a highly sensitive gamma-ray spectrometer to count the resulting radiation from elements within the samples, they found indisputable proof that the bits of paint came from the suspected sources.

The seven basic elements in the sample of brown paint from the jack handle also existed in a paint sample scraped off the liquor-store door. The concentrations matched, too. There were no ingredients in one—even trace impurities—that did not exist in the other. Similarly, Dr. Guinn and his men found corresponding concentrations of five basic elements in the blue paint on the jack handle and in blue paint from the trunk of the suspect's car.

After the tests were completed, the samples, still intact in spite of having been irradiated, were placed in small plastic vials and shown to the jury. The nuclear experts' testimony provided the clincher. The suspect was convicted.

Cases hinging on the use of NAA are just beginning to appear on court calendars. For the past 3½ years, however, Dr. Guinn and his colleagues at General Atomic's labs have been experimenting with it for crime detection under a research contract with the AEC, frequently with the cooperation of the Los Angeles police and the FBI.

Perhaps the most important work done so far is devising a greatly superior method of determining whether or not a suspect has fired a gun recently. The old-fashioned method involves brushing paraffin on the suspect's hands and then chemically analyzing the paraffin casts to see if gunpowder is present. The test is far from conclusive. NAA, on the other hand, when applied to the same paraffin casts, reveals even the merest

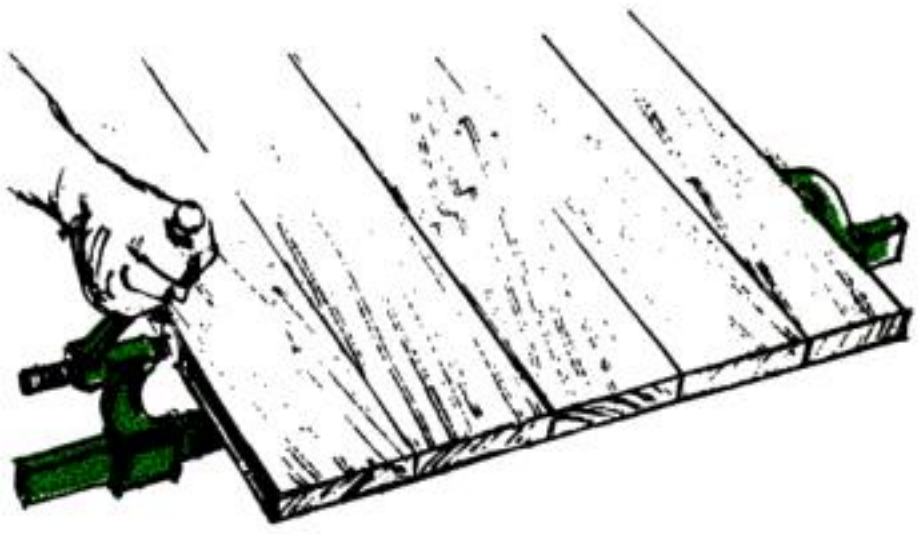
[*Continued on page 162*]

Urheberrechtlich geschütztes Material

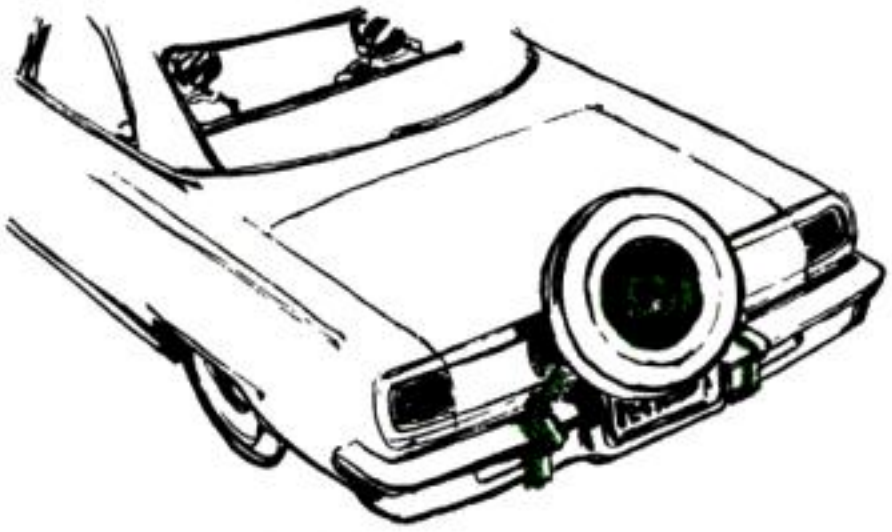
"I'd like to see them make..."

Collapsible spotlight poles, pointed at the end to stick into earth or sand. They'd hold battery-operated lights on a beach, patio, or camp site.—*David D. Katz, Hershey, Pa.*

A suntan-oil applicator that would permit a loner to reach his own back. Oil in a long hollow handle could flow to a sponge pad at the base.—*Randall Bergquist, San Diego, Calif.*



Bar clamps that tighten by ratchet action instead of with a crank or handle. They'd be great for making butt joints on 10- or 12-inch boards.—*R. McCormick, Ames, Iowa.*



A spare-tire bracket to mount on the bumper. With an accessory like this to make extra room, there'd be trunk space for vacation luggage and camping gear.—*R. Lufkin, Evansdale, Iowa*

Visual mail call for rural mailbox owners. A battery-operated neon lamp would light as the door is opened, stay lit until reset by the householder.—*R. Miller, Wheeling, W. Va.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's *yours?* We will pay $5 for each one published. Please use Government postcards only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 10017. Write your name and address clearly. Contributions cannot be acknowledged or returned.

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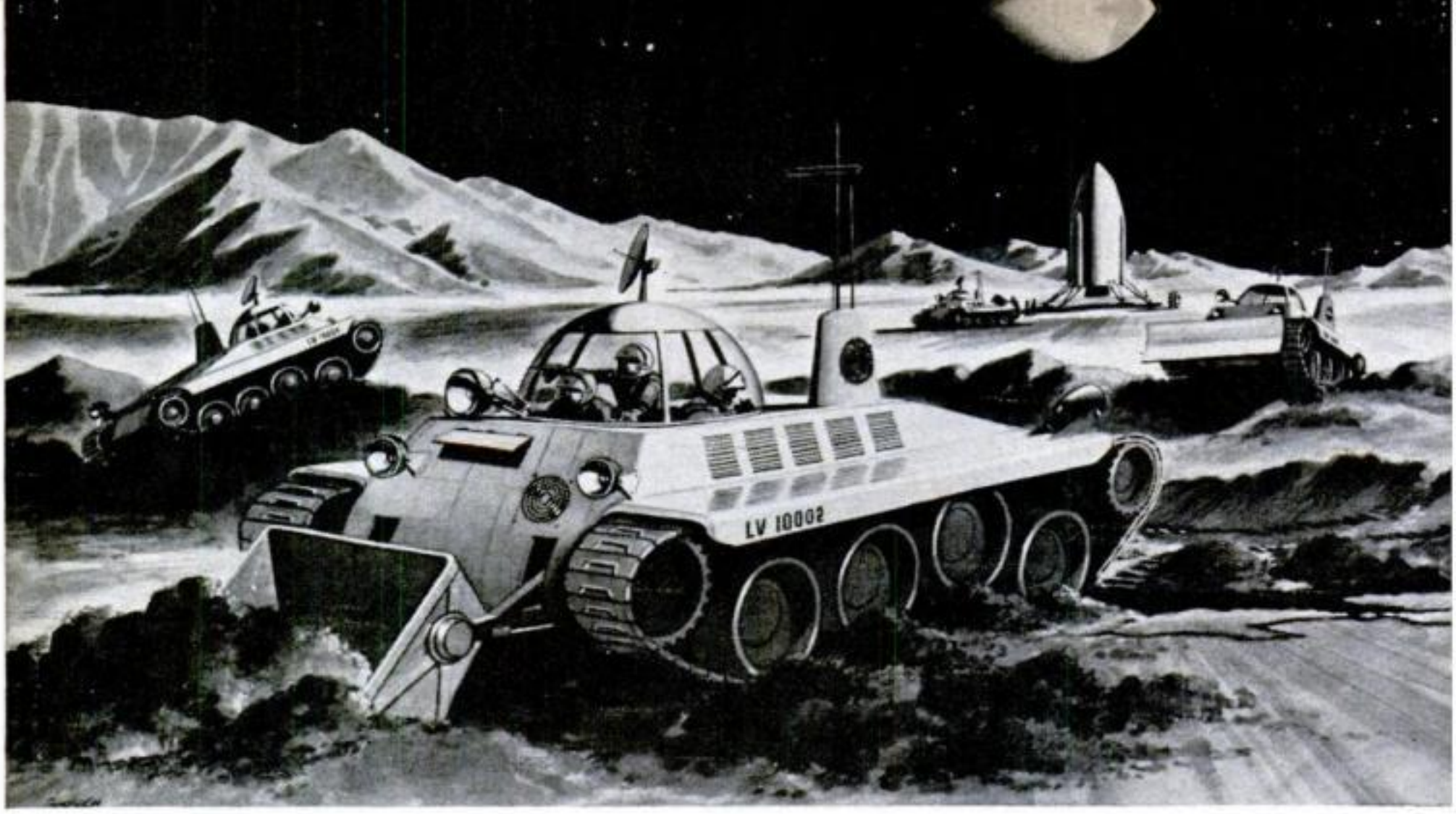

Vehicles powered by fuel cells are pictured constructing a future base on surface of moon.

New advances promise more and longer-lasting—

ELECTRIC POWER

A fuel cell for Gemini, and orbiting atomic batteries and reactors, offer latest ways to put juice on tap in the sky

By Dr. Wernher von Braun

Director of NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

Dr. von Braun, left, outlines to PS Editor Ernest V. Heyn his ideas for coming articles on news-making developments in space science.

A NEW kind of electric-power supply for space vehicles will make its debut in the third manned Gemini flight, due this month. A fuel cell, a novel and promising source of electric current, replaces the silver-zinc batteries that the two-man Gemini spacecraft have used before. Likewise, a fuel cell will furnish electricity in the three-man Apollo spacecraft that will go to the moon.

Space vehicles need electric power, both in rocket-propelled and coasting flight, for all sorts of vital gear: life-support systems, radio, propulsion control, guidance, instruments, and more. Electric power will be required, too, for a lunar base.

Advancing technology offers a widening choice of electric-power sources for space—chemical batteries, fuel cells, solar cells, atomic batteries, and nuclear reactors, to name the more-important ones. Which of these systems will a

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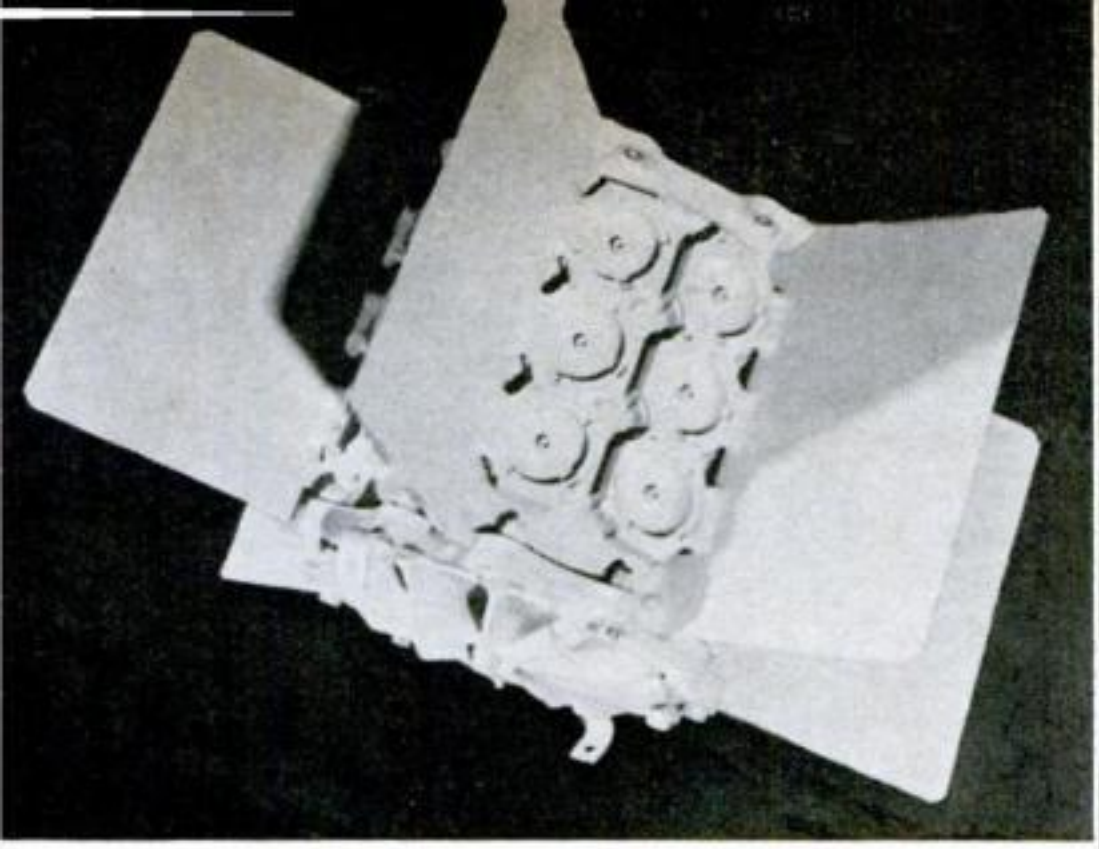
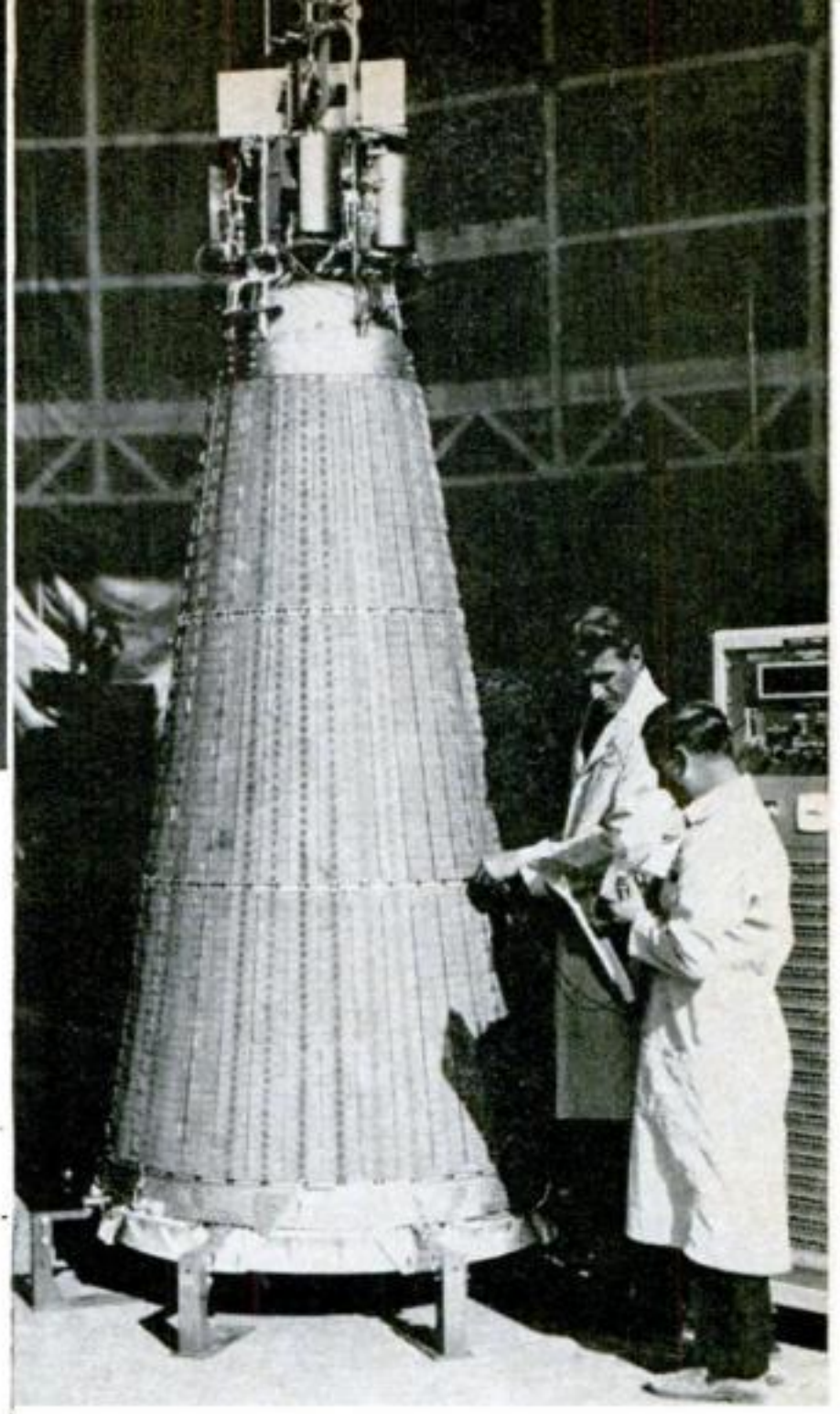




Nuclear electric-power sources are long-lived and independent of sunshine or shadow. Atomic batteries like 20-inch-diameter SNAP-9A, above, turn radioisotopes' heat into current for modest power needs of satellites. Higher outputs will come from chain reaction in nuclear reactors, of which the first in space—SNAP-10A, at right—was put in orbit for trial last April.

IN SPACE

space-vehicle designer choose, and why?

Chemical batteries have been a mainstay since the Space Age's beginning. They powered the earliest satellites—Russia's first two Sputniks and our Explorer I. All our manned spacecraft, of the Mercury and Gemini flights, have depended on them. Chemical batteries are still unchallenged as electric-power sources for launch rockets, which demand as much as several kilowatts of power, though for only a few minutes.

Advanced types like silver-zinc and nickel-cadmium batteries offer more power for less weight than the less-expensive lead battery in your car. However, chemical batteries are prohibitively heavy for long use—more than a very few weeks—without recharging.

Fuel cells, while related to chemical batteries in principle, represent quite a radical departure in form. Hydrogen gas and oxygen gas are fed into the tanklike fuel cell. What comes out is an electric current—up to a kilowatt or two, in present designs for spacecraft—and a little water.

A fuel cell thus requires a supply of hydrogen and oxygen, carried along as high-pressure gases or in liquefied form—and can operate only so long as the supply holds out. This gives it a limited life, comparable to that of chemical batteries, for space uses.

For manned space vehicles, however, a fuel cell's attractions are enhanced by the fact that the water it produces is potable. Drinking water must be provided for the astronauts anyway. So it might as well be taken along in the form of hydrogen and oxygen—which, combining in the fuel cell, will generate electricity and replenish the drinking-water dispenser in the bargain.

Fuel cells are attractive for lunar surface vehicles, too. They would make "moon cars" independent of the sunshine

[*Continued on page 160*]

Urheberrechtlich geschütztes Material

HALF-HOUR after airdrop of the hospital, beds, furniture, supplies for 24 hours, and first patients are moved in. Photo was taken at Army demonstration at Camp Bullis, San Antonio, Tex.

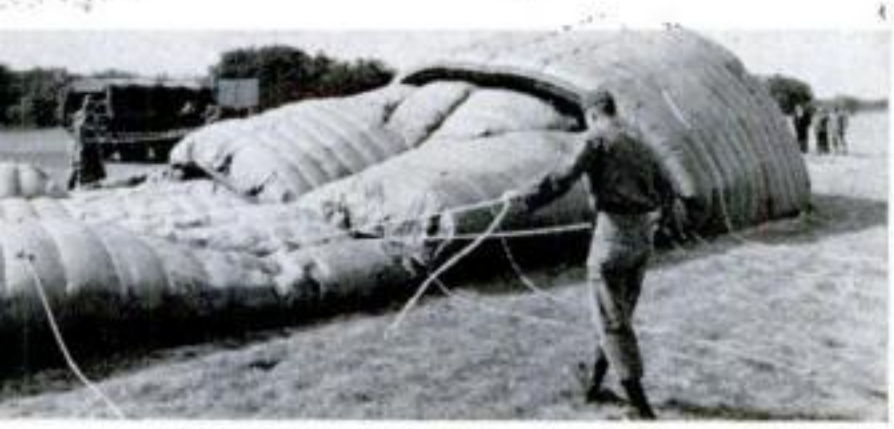
Portable hospital up in 30 minutes

In case of disaster or battle this inflatable hospital can be flown or trucked in and be ready for patients 30 minutes after it reaches the scene. Called MUST by the Army (Medical Unit Self-Contained, Transportable), it's accompanied by a utility pack containing a gas-turbine engine to pump up as many as six 13-foot hospital sections. Running on almost any fuel, the turbine also generates electricity for lighting, air conditioning, and hot water. Four sections zippered together form a weather-sealed 20-bed ward.

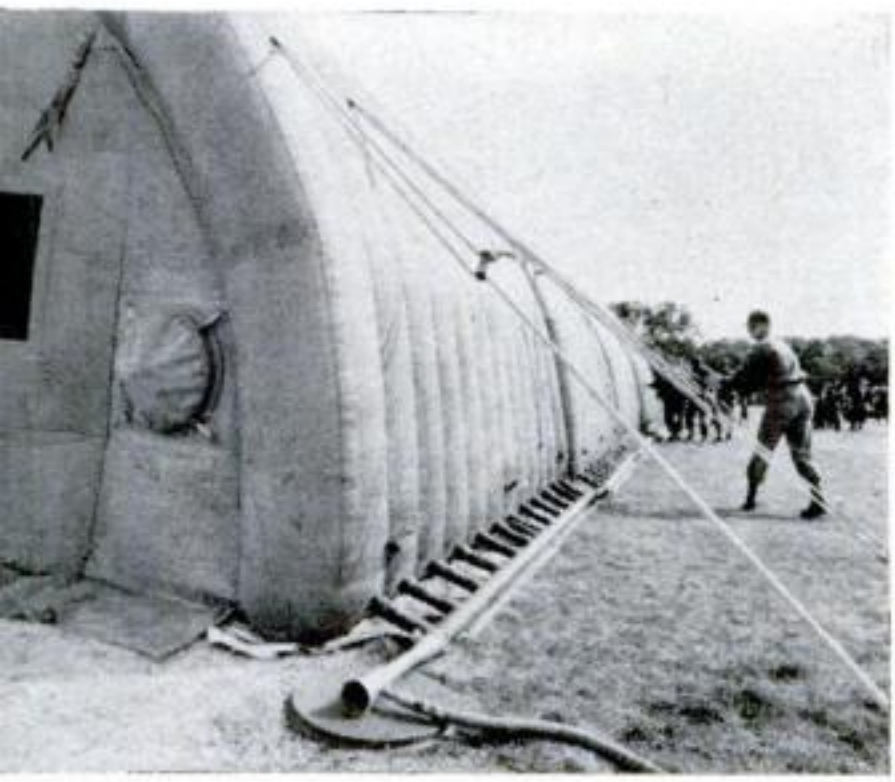
In addition to the ward, there are expandable elements for surgery, X-ray, dentistry, supply room, pharmacy, or clinical laboratories. Each of these is a rigid, pressurized 12-by-18-foot room with a 7¼-foot ceiling, an air-lock door, and supplies for 24 hours. Any number of sections can be zippered together to form up to a 400-bed emergency hospital.

Urheberrechtlich geschütztes Materia

IMMEDIATELY on airdrop, ward is spread, compressor (foreground) starts.



IN TWO MINUTES, building, with 13-foot sections zippered, takes shape.



IN SEVEN MINUTES it's fully inflated. Air hose, valves go to individual cells.

IN 30 MINUTES, first patient goes on stretcher through air-lock door.

Polaris sub flips its lids

With the tops of all 16 missile tubes raised, the newest Polaris submarine, the Sam Rayburn, commissioned last December, ties up at a dock for inspection. The nuclear-powered undersea craft can launch its Polaris missiles while either surfaced or submerged for a strike far inland. It ejects them by compressed air. Polaris range is nearly 3,000 miles.

Tool for the moon or the ocean floor

Burning two liquid propellants in a combustion chamber in its handle, the tool shown here can bore for samples on the moon's surface or the ocean's floor. The gases generated drive its turbine for five minutes. Developed by Sperry-Vickers, the PLANETool also has heads for welding, cutting, or hammering. Extra cartridges can be carried in a belt.

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I Survived a Jungle

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Survival Test—Could You?

PS reporter's ordeal—a five-day Air Force Commando Survival Test in a Florida swamp, battling heat, bugs, and hunger

By Robert Gannon

THE moon was full and the Florida air was warm, but the stinking, thigh-high swamp water we were standing in chilled us, as we waited for the rendezvous.

"There's the plane," said Capt. Keith R. Grimes, as its navigation lights appeared among the stars. "They shouldn't have any trouble seeing us." He was shining a hooded flashlight upward to signal them.

"Now!" he said as the plane came directly overhead. Suddenly a black dot slid across the face of the moon. Then it expanded into a parachute.

The chute descended in silence. Then we heard the sickening crunch of tree branches. "Oh, no," said Grimes. "He missed the drop zone. Come on."

"I was loaded down with a poncho and a 45-pound pack filled with emergency flares, nylon line, and some K rations."

I was in remote northwest Florida with three Air Commandos (the fourth was just arriving)—volunteer, behind-the-lines fighters of the Air Force's Tactical Air Command.

Air Commandos learn how to survive in the wilderness where they sharpen their wits by living off the land—half woods, half swamp wilderness. I went along to see how a typical civilian could stand the rigors of the strenuous test.

This training mission was set up for members of a Combat Weather Team. Their job: to gather weather data from "enemy-held" territory.

Two team members—Grimes and M/Sgt. Thomas M. Watson—are meteorologists; the other men in the seven-

CONTINUED

PS Reporter Robert Gannon climbs through brush of a Florida swamp during five-day survival march with Air Force Commandos.

Urheberrechtlich geschütztes Material

"Crossing a river by sling is easy—in theory. But the pack pulled my head down for a few unscheduled duckings. Finally they threw me a rope and pulled me across—humiliating."

man outfit are highly skilled forecasters.

At Hurlburt Field the day before our trip was to begin, I was issued heavy boots, jungle fatigues, poncho, machete, hunting knife, and a rucksack-type pack filled with emergency flares, nylon line, and K rations. Grimes gave me his old lopsided, made-in-Vietnam, Gurkha-type bush hat, official headgear for Air Commandos. Then for three solid hours, T/Sgt. Stanley M. Monie drilled me in the art of wilderness survival.

Just after dawn on a blustery Friday, Grimes, Monie, Watson, and I took off in a C-47 cargo-troop plane. From the open doorway I could see part of the area below—800 square miles of Eglin Air Force Base—in which we would spend the next five days. From the air it looked like deep jungle, with an occasional swamp, logging trail, or meandering river.

We landed on a crude airstrip in a clearing. I got off alone. The plane roared up again. The others, trained in jumping, parachuted in.

"During one hour-long stretch we made only 1,000 feet, hacking our way through brambles and sloshing through stinking, gooey mud."

Our plan called for us to zigzag across 45 miles of wilderness on foot. But our immediate goal was to meet weather team member Wayne Golding some 10 miles south, an hour after sundown. He would parachute in.

A nightmare hike. We waded through swamps, hacked our way with machetes through brush, tangled ourselves in briar patches (with spikes two inches long), plodded up sand hills, rolled down ravines. Everyone but me seemed to find it exhilarating.

My feet were wet and hurting, my back was sore, my face was scratched. No one else had a complaint.

At the end of the 10-mile hike, Grimes climbed a tree as though there were a stepladder leaning against it. When he was 40 feet above the ground, he turned his pocket transit on its side to get the angle of elevation of the clouds. Then, through a neat method of sighting the clouds' reflection on the lake, he determined their height; and by timing them as their reflection crossed the transit's glass face, he checked both the direction of the wind and its speed.

Urheberrechtlich geschütztes Material

Meantime, Watson had filled a 100-gram red balloon with helium from a metal pressure bottle. He released the balloon and Grimes tracked its ascent. The rate of climb of a helium balloon of known size is always the same, so if you can measure the angle at which it rises—Watson did it with his pocket transit—you can accurately determine upper-air wind speed.

Watson sent up another balloon after nightfall, just before the plane carrying Golding was expected. This one dangled a tiny light bulb. With a final reading, Captain Grimes and I took up our post a quarter-mile upwind—which just happened to be in that swamp.

Standing in the rancid water, waiting for the plane, Captain Grimes talked about some of the overseas activity his group has seen in the last year. Most of the assignments are still under wraps, but some can be told. For example, the team recently went into dozens of tiny Greek villages—four of them required parachute drops—and taught the people to make crude weather instruments (rain gauges, weather vanes, anemometers, hair hydrometers), showed them what kind of observations are important, and set up the framework for a clandestine weather network.

Finding Golding. As we sloshed through the fetid water toward Golding, I hoped the splintering sound had been branches, not bones. It had been. There was Golding, comfortable as could be, still in his harness, swinging jocularly a yard from the ground, his chute draped over a live oak tree.

Breakfast the next morning consisted of K rations and a handful of raspberries. "But nobody need go hungry in the American forest," said Monie. "For example, almost all flowers and grasses are edible. But stay away from any that burn the tongue or have milky sap."

The day was interminable—particularly during one hour-long stretch in which we progressed only about a thousand feet, hacking through brambles while we sloshed through stinking, gooey mud. In the 90-degree heat we sweated off the mosquito repellent as fast as we could apply it.

[*Continued on page 182*]

Urheberrechtlich geschütztes Material

New Ideas from the Inventors

Hook catches mooring float. This recently patented mooring catch would let a boatman pick up his mooring line without leaving his seat: He'd maneuver his boat so that a vertical rod on the mooring float slipped into a U-shaped hook on the bow. As it entered the hook, the rod would slip past a retaining spring. For times when the boat was docked or under way, the catch would swivel down flat.

Worn brake sounds warning. Mounted on a brake shoe, this small noise maker would normally be held away from a brake lining by the thickness of the shoe. But dangerous wear would let the wheel run against the drum (inset), turning another wheel against a spring finger and thus generating a high-pitched noise to warn the driver.

Nailing clamp holds siding for you. These adjustable spacer clamps could make the nailing up of siding a one-man job. With the bottom legs hooked under the previous row of siding, two or three clamps would support and level the next length. Supporting springs would hold the clamps and siding against the wall during nailing.

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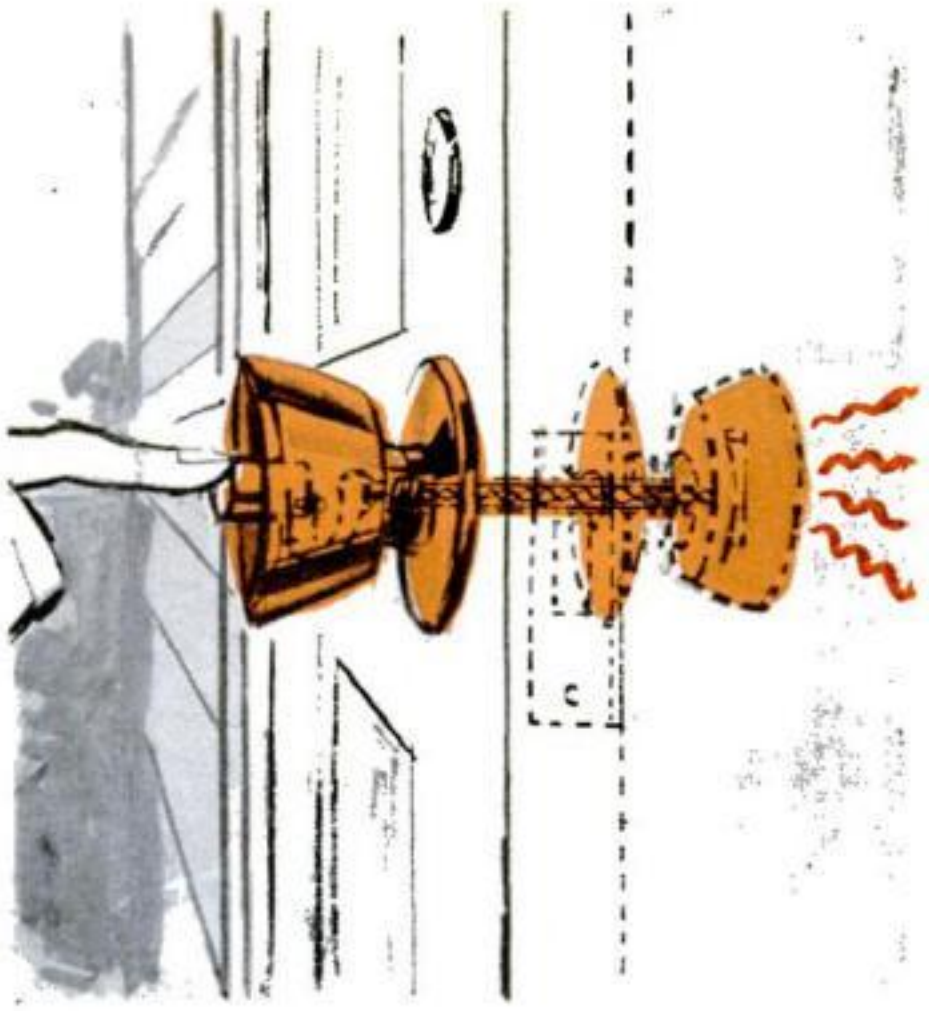
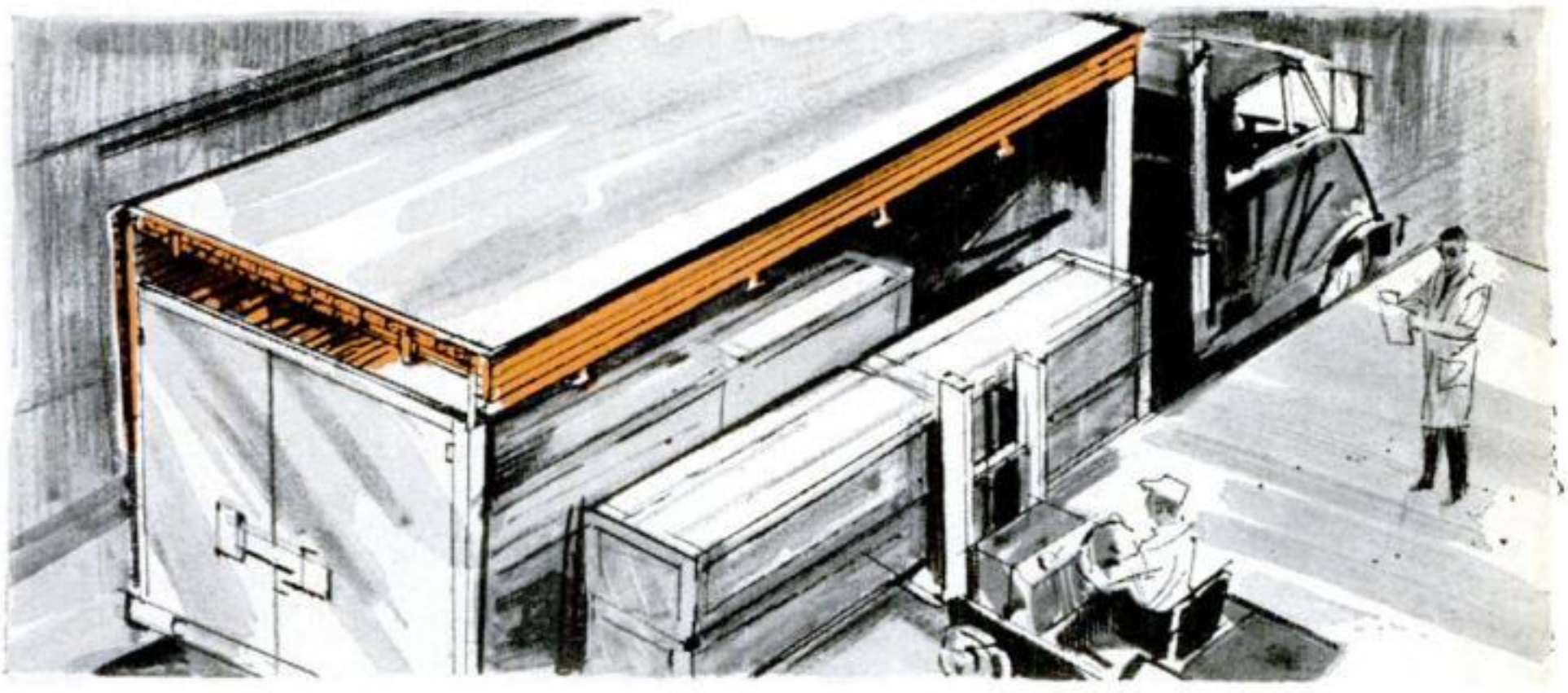


Doorknob rings the bell. You could install a bell on any outside door without the nuisance of wiring if you substituted this set of knobs for your present set. A button in the outside knob would be wired—through the hollow shank—to a miniature buzzer and battery in the inner knob. A cap would unscrew for battery insertion.

Ladder filters back-yard pool. All the piping needed for filtering and recirculating swimming-pool water could be built into a compact ladder structure adaptable for in-the-ground or above-ground pools, says this inventor. His aim: to lower pool cost and simplify installation—especially in knock-down, tank-type pools.



Roll-up sides speed truck loading. Flexible slatted sides that would roll up like garage doors might simplify truck loading by allowing either side to be opened. For loading, the sides would ride in guide rails up under the roof. Closed, they'd latch to the truck bed. For extra-tall loads, the roof of the truck would elevate.

The following patents have been issued on these inventions. **Mooring catch**—*No. 3,083,676 to H. W. Andersen, Manhasset, N.Y.;* **Brake alarm**—*No. 3,139,063 to Frank Rinkerman, Clifton, N.J.;* **Siding clamp**—*No. 3,133,357 to Leo A. Gayan, Ironwood, Mich.;* **Doorknob bell**—*No. 3,168,730 to F. A. Baldinelli, Milton, Mass.;* **Pool ladder-filter**—*No. 3,090,489 to George L. Smith, St. Louis;* **Roll-up truck sides**—*No. 3,140,116 to William D. Speas, San Lorenzo, Calif.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D.C. 20231, at 25 cents each. To write to an inventor, if the address above is insufficent, address him (by name and patent number) in care of the Commissioner of Patents.

Urheberrechtlich geschütztes Material

Giant scoop begins digging operations around roots of tree before moving it to new location.

Tilted back on carrier, it transports tree. roots, and soil for planting in new excavation.

Mammoth shovel transplants full-grown tree

The huge blade of the tractor-mounted shovel above not only scoops a big tree out of the earth. but it tilts back on the machine and transports the tree—roots, soil, and all—for replanting in a new excavation. The powerful 150-hp. diesel unit saves costs for the British National Coal Board. They use it in landscaping after open-pit mining.

Jointed action smooths out rocky trail.

Four-wheel drive takes steep grade in stride.

Swivel-jointed vehicle needs no highway

Latest off-road vehicle is this car built in three independent sections. It masters rocks in its path, steep slopes, ditches, can even swim rivers. Called the Sidewinder because of its snakelike undulating movement over rough ground, the ¾-ton four-by-four was

Urheberrechtlich geschütztes Material

Swinging from rope, a novice climber practices scaling on "Tokyo Rock."

Man-made mountain

Built of vinyl-coated concrete in the heart of Tokyo's shopping center, a man-made 66-foot cliff, complete with ledges, ridges, and plastic flowers peeping from crevices, juts from the corner of a sporting-goods store. Instructors and nets are provided along with mountain-climbing practice to keep novices from falling too hard.

Six-story cliff at store's corner has every challenge for mountain climber.

Down into and up out of ditch is easy.

Spinning tires swim stream at two m.p.h.

built by Chevrolet for the Army. Swivel joints between sections give the machine a rolling action with constant wheel-to-ground contact over foot-high stones, two-foot walls, and other obstacles. The front section contains the driver's seat, the second the engine and accessories, and the third an interchangeable cargo compartment. Each section is sealed watertight for swimming; large, low-inflation tires give buoyancy to the vehicle; the rear swivels like a rudder for steering in deep water.

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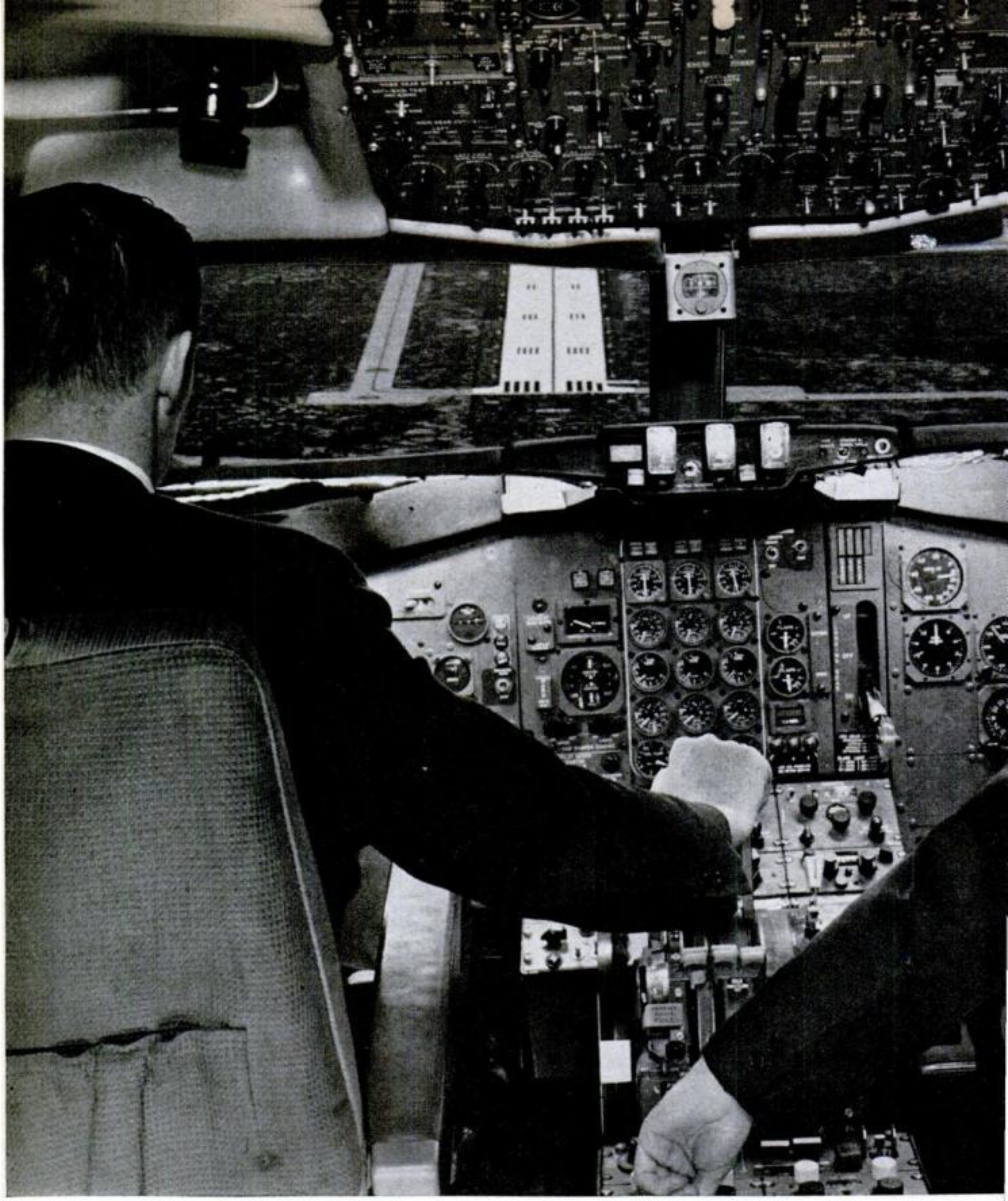


How to Become

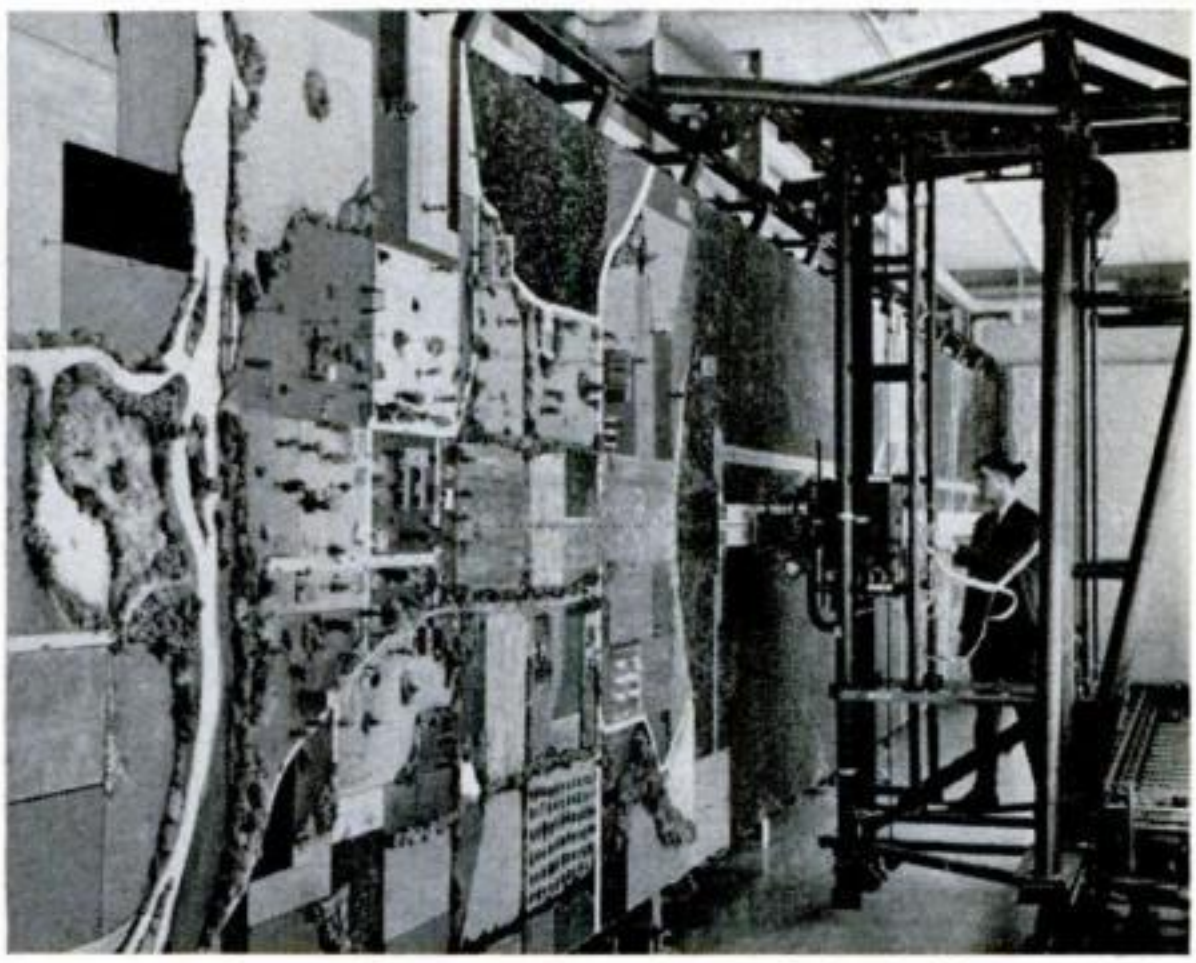
Come along with us on a picture tour of the world's best school for what are undoubtedly the world's best-paid part-time jobs

By Devon Francis

Urheberrechtlich geschütztes Material

Here's how it looks from up front—in a "simulator" anchored to the ground—when a jet airliner comes in for a landing. The speed over the airport boundary in this particular airplane is 120 knots (about 138 m.p.h.) at a maximum permissible landing weight of 135,000 pounds. The "plane" is a Boeing 727 with seats for 91 passengers. The runway that the trainees see ahead is actually a closed-circuit, black-and-white TV image on a big screen. Simulator reproduces flight conditions so realistically, though, that students subjected to emergencies by instructor sometimes leave the flight deck shaky. These men are training to be second-in-command—first officers.

Findlay, in first officer's seat (right, in photo): "Well, here we go from everything we learned in suck, squeeze, bang, and blow [piston engines] into scoop and whoosh [jets]."



Camera trick provides view through the flight-deck windshield. Actually, the miniature landscape stands on edge (above), facilitating the installation and servicing of the TV scanning camera. Motors responding proportionally to movement of flight-deck controls move the camera to simulate turns, altitude, and speed. Color soon will supplant black-and-white TV. Landscape is complete, down to and including highway systems, billboards, homes, factories, telephone lines, grain elevators. Trees and shrubs are "reindeer moss," used in model railroads.

Butterer: "You fly it all the way down. You can't say you've got your approach wired until the wheels are on the ground. You know, I almost got my arm broken when I started commercial training. I couldn't learn to ask the first officer for flaps instead of doing it myself, like in B-52s [bombers]."

an Airline Pilot

IN DOWNTOWN Kansas City, Mo., there is a building full of classrooms for students aiming at salaries so big as to put them in uncomfortably high tax brackets. And this, mind you, for working only part time—about 80 hours a month. That's what their union rules specify.

The building houses the most elaborate training school in the world for

CONTINUED

Urheberrechtlich geschütztes Material

Computers program the behavior of each type of airplane,

Student crew—Butterer as captain (left), Findlay as first officer, Francis as flight engineer (foreground)—dons oxygen masks to simulate loss of pressurization. Computers program the characteristics of each type of transport used in training, and duplicate airplane, control, and instrument responses that the trainees will meet when they start flying real airplanes.

Flight engineer's panel behind first officer, formidably complicated at first glance, holds informative dials and controls neatly divided up among electrical and hydraulic systems, lubrication, engine operation, fuel management, pressurization, and air conditioning. Most important engine instruments, for the 727's three jets, are duplicated on the pilots' bulkhead.

Findlay: "We've got a new gadget on the main panel. It's an instrumented flying aid called a flight director. Its versatility amazes the most seasoned pilots."

Francis: "Everything's different on jets compared with props. It's 'thrust levers' for throttles; instead of manifold pressure for power, it's engine pressure ratio."

commercial-airline flight crews. In this school a man learns how to become an airline pilot. If he makes captain in a few years, he can earn $25,000 a year flying domestic routes, and up to $35,000 if he flies the oceans.

The students in training are pretty lucky fellows. The airline business is booming, a lot of pilots are nearing enforced retirement, and the pilot reservoir airlines formerly depended on—the Air Force and the Navy—aren't training as many fliers as they used to.

This school, TWA's International Training Center, turns out fine pilots. It's to these classes that the crew of Air Force One, the personal jet transport of the President of the United States, returns periodically for "proficiency checks."

Mainly, the school is the training ground for flight crews of Trans World Airlines. Eighteen other airlines, domestic and foreign, also have used it.

Most airline training takes place not in the air, but on the ground—in the classroom and in the cockpits of "simulators" that are exact duplicates of the real thing, right down to the last rivet and toggle switch.

Does a career as a flier appeal to you? POPULAR SCIENCE picked three of the school's trainees to demonstrate how you become an airline pilot. Like all TWA's "new hires," all were already qualified pilots. They were James F. Findlay, 23, of Meadville, Pa.; Richard Butterer, 32, of New Hope, Pa.; and Devon Alan Francis, 22, of Denver (son of the author of this article).

The quotes with the picture captions are asides made by the trainees while the pictures were being made.

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and the instructor punches in any emergency he desires

Captain's main panel carries (in vertical rows starting at left) dials for speed in knots, radio compass, speed in Mach number, flight director, course deviation, altimeter, rate of climb, turn-and-bank, engine ram-air temperature, nautical miles to destination. Complex flight and navigation aids on today's jets have added new techniques (and instruments) that crew must know.

Console between captain and first officer carries controls for transponder to identify plane to ground radar, navigation and communication radios, automatic pilot, flight-director control, thrust levers, handles to operate speed brakes and flaps, engine starters, and trim tabs for the two rudders and ailerons. Just above is a whole battery of engine instruments.

Butterer: "A flight director's just a black box to tell you where your airplane is in relation to where you want to go or what you want to do—hold a heading, say."

Francis: "The crazy thing about jet engines is that you can get high-speed stalls in the spools [compressors] as well as in low speed."

The man who teaches 'em how in 727 trainer is imperturbable Capt. John Rhodes, a veteran of more than 18,000 hours aloft, 4,000 in jets. By punching buttons on this special instructor panel, he can simulate practically anything—from an engine fire or loss of hydraulic pressure (rare) to rough air, a radio malfunction, or even thick, slick slush on airport runway.

Hydraulic jackscrews in pit below simulator turn it on its three axes. Butterer and Findlay had eight weeks of instruction in class, simulator, and actual flying, and 20 hours of "line check" before becoming first officers. Francis, as pilot-flight engineer, had 10 weeks' instruction, 10 hours of line check. All previously qualified pilots, they spent hours at homework nightly.

Findlay (speaking of "new hires" making transition to big jets): "We make four 'landings' to get down—feel as if we shed an engine on each bounce."

Butterer: "Don't let anyone tell you you don't have to worry about the barber pole [a limit marker on the knot meter] if you're going downhill. It isn't true. ■ ■

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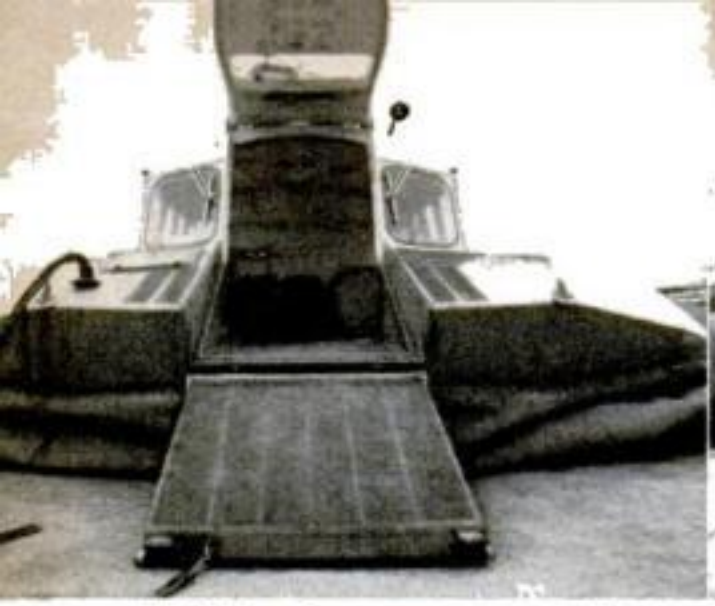


Waiting for passengers, the Port of Oakland squats in its deflated skirts. The GEM crosses land and water in minutes to cut an hour or more from travel time by car between two airports.

Whine of turbojet rises to a scream as propeller and fan (mounted horizontally in hull) begin to spin. GEM's skirts inflate and it rises off pavement. For size, note figure at right.

Spacious cabin comfortably seats 15 passengers and pilot. For safety, life jackets are under seats, and windows can be pushed out to exit, but craft will float even without skirts inflated.

Ride with a PS editor on the first regularly scheduled air-car transportation in the U.S.

Across Land and Sea

By Wesley S. Griswold

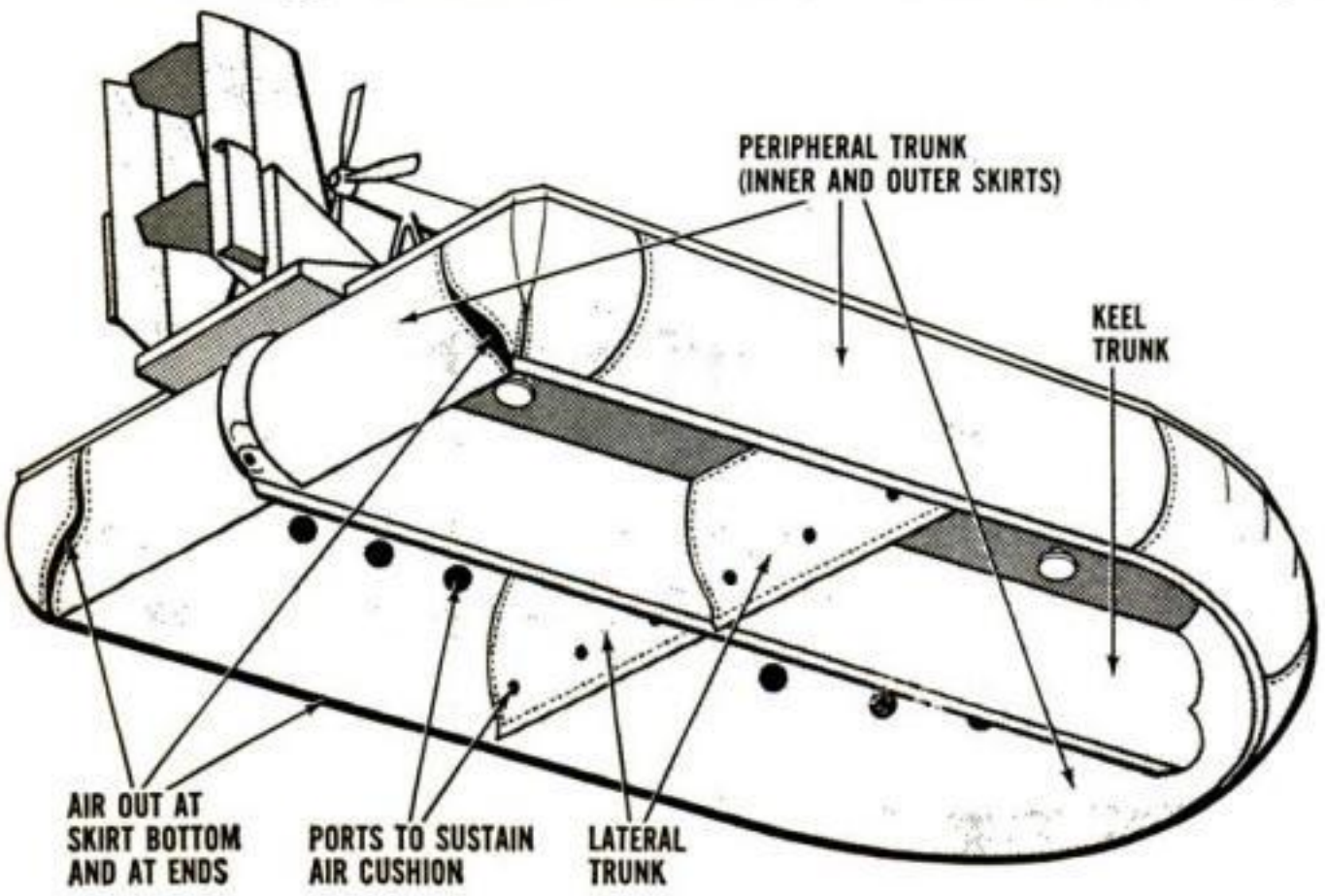
I'VE JUST had an exhilarating ride across land and water on a four-foot cushion of compressed air in an amazingly comfortable machine that's a blend of bus, boat, balloon, and helicopter.

The vehicle was a pert little 15-passenger Hovercraft, one of a pair that have become the first ground-effects machines (GEMs) to enter commercial passenger service in the U.S. The British-built GEMs have recently begun ferrying travelers at 60-80 m.p.h. across the 10-miles of bay between Oakland and San Francisco international airports.

SFO Helicopter Airlines is operating the GEMs as an experimental adjunct to its thriving whirlybird service. Sponsors of the 20-month experiment are the U.S. Housing and Home Finance Agency, the Port of Oakland, and Bell Aerosystems Co.

The morning on which I rose above the ground and took off on a magic-

Floating on an air cushion, GEM travels at speeds up to 80 m.p.h.



Skirts and trunks compress air from lifting fan into four compartments to aid stability and control. Air pours out along bottom edge of skirts, and through ports cut in keel and lateral trunks. Controls are simple; radar and radio are included.

on a Hovercraft Ferry

carpet glide across the bay was bright and brisk. The Hovercraft, christened Port of Oakland, looked like the upper half of a cabin cruiser snuggled in a nest of tarpaulin. The nest was the inflatable rubber tubing through which air is forced beneath the vehicle to make it airborne.

A section of bow pulled out to form a gangplank and a part of the windshield opened outward to let the passengers aboard. The roomy interior, lighted by big windows, has two rows of cushioned seats with an ample aisle between. The instrument panel and controls looked so simple that I asked the pilot if the Hovercraft was much easier to fly than a helicopter.

"Not really," he said. "I've handled both, and I'd say they were about equal in their demands on your wits. Of course, it's handy to be only 4½ feet off the ground if anything goes wrong."

"How fast could you stop, out over the water?" I asked.

"In about three lengths. I'd just chop the throttle, and the air would immediately start draining out of the skirts.

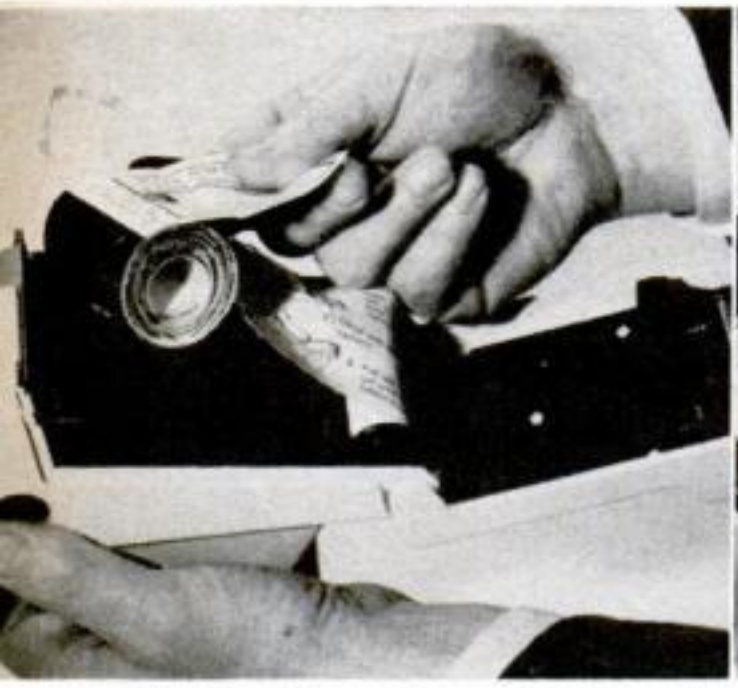
[Continued on page 178]

As craft approaches beach, moving hollow in which it rides in water, created by compressed air, can be seen (top). Still moving rapidly, GEM glides smoothly onto beach. Distance between ground and skirt bottom is six inches; aluminum craft itself is four feet higher.

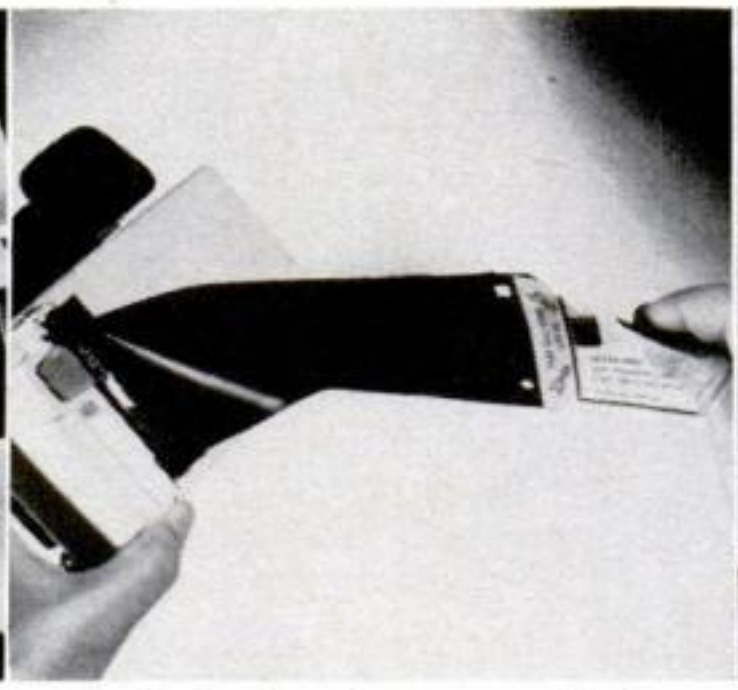
Urheberrechtlich geschütztes Material

THE

Simple's the word. Drop in the film . . . pull the tab . . . shoot



1 Loading takes only seconds. The film can't go in wrong. You drop in the two rolls (small one first) and lock the camera. At the back, there's a slip of paper sticking out.



2 Push the button, pull the paper straight out, and tear it off. You're ready to shoot after you set the aperture (see text). There's no focusing: The plastic lens is fixed-focus.

3 Press the shutter release— and the picture is taken. Shutter speed is a constant 1/200 second. The aperture, which ranges between *f*/17 and *f*/96, controls the exposure.

Urheberrechtlich geschütztes Material

PS PHOTOGRAPHY

SWINGER— New $20 Polaroid

The price is right, developing time is only 10-15 seconds, and the exposure system puts every picture on the nose

By Everett H. Ortner

FOR a double sawbuck now, you get not only a Polaroid camera but also a chance to admire one of the simplest and smartest exposure systems since the day, a century and a quarter ago, when Daguerre first squinted into the sun and shot a picture of a man getting his shoes shined.

The camera is the brand-new Swinger, just announced by Polaroid. It gets its name from the way you carry it—on a wrist strap. It shoots only black-and-white pictures, 2½ by 3½ inches.

It resembles other Polaroids only in its stainless-steel rollers (which squeeze the pods within the film to release the goo that develops the picture).

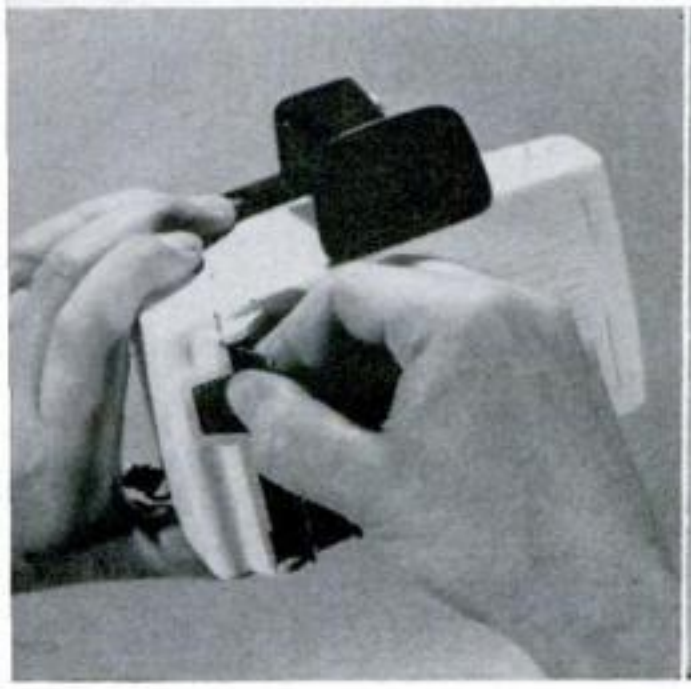
It offers many new features:

- The film develops *outside* the camera. After you shoot, you pull the exposed film out, give it 10-15 seconds, peel off the print.
- The flash is built into the camera. You drop a little AG-1 flashbulb into a socket on top. The clear plastic faceplate acts as a diffuser.
- A distance scale helps you set the aperture accurately for flash.
- A brilliantly simple exposure system lets you adjust the aperture accurately for available-light pictures.

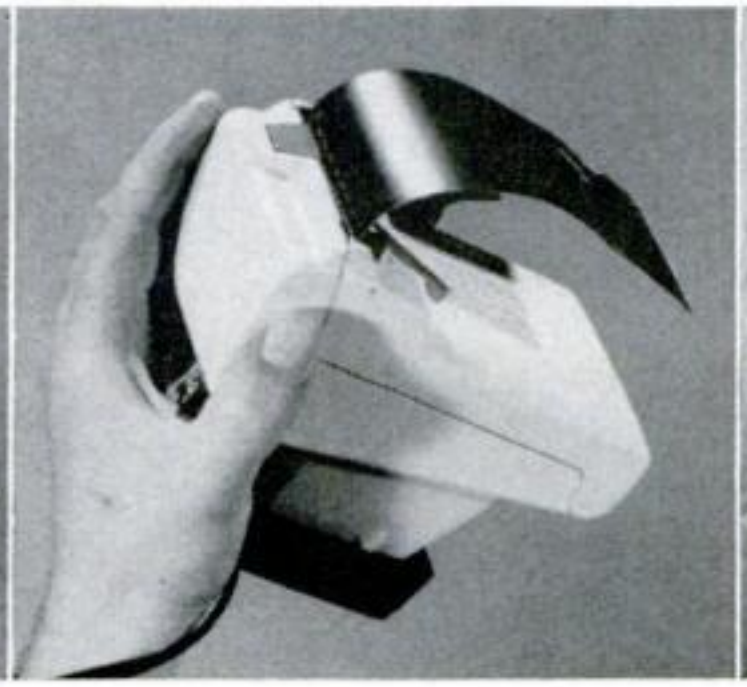
That exposure system is worth exam-

CONTINUED

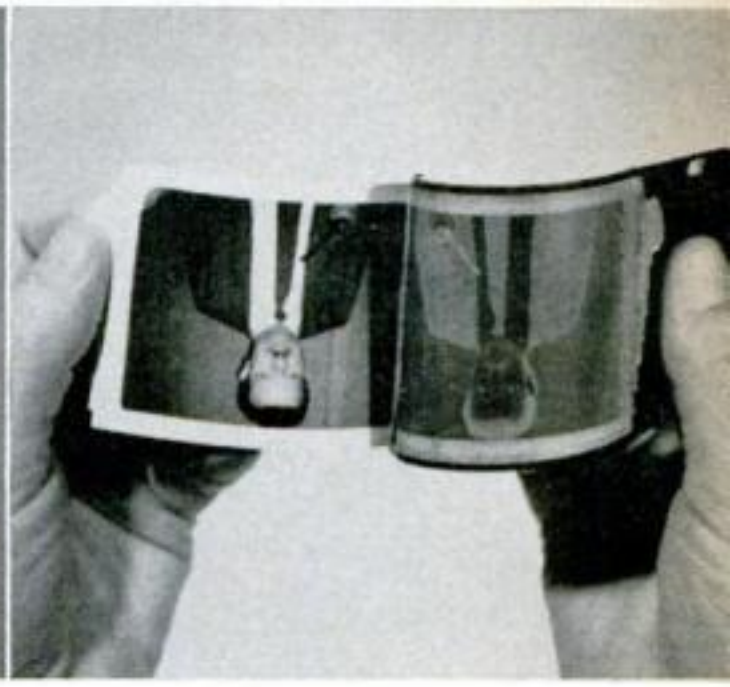
. . . pull the tab . . . wait 10-15 seconds . . . peel off the picture



4 To start developing, you press thumb button, grip end of paper, pull it straight out. A finger in the camera locks in a small, square, reinforced hole in the film to stop it.



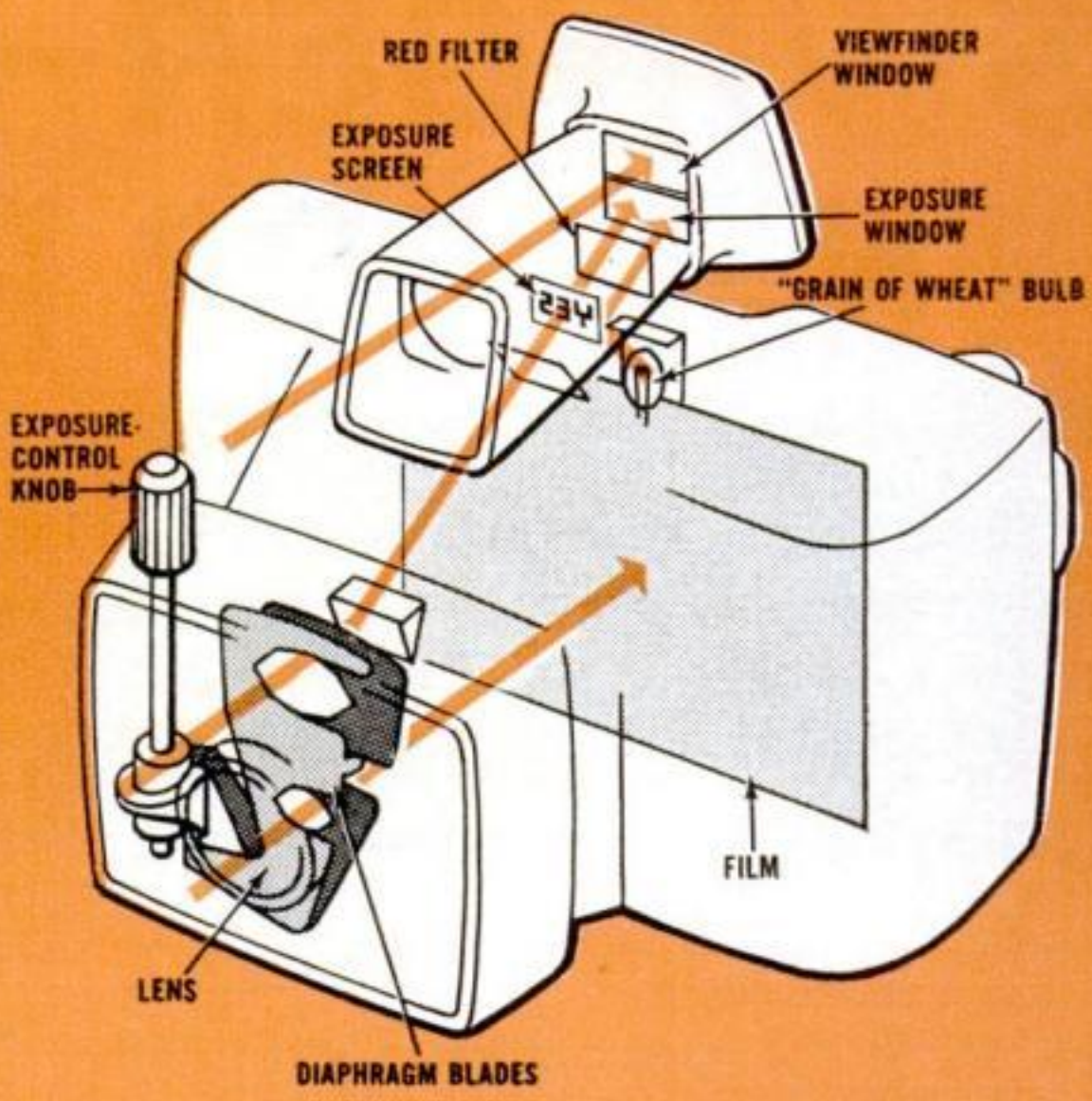
5 Wait 10-15 seconds while film develops outside camera. Developing gel, from pods broken by rollers, is squished through sandwich of film and paper when you pull paper out.



6 Peel off the print and the job's done. A print coater, packed with the film, makes the picture permanent; uncoated, pictures begin to fade and streak within a matter of hours.

Urheberrechtlich geschütztes Material

Swinger's exposure system: "YES" means it's okay to shoot



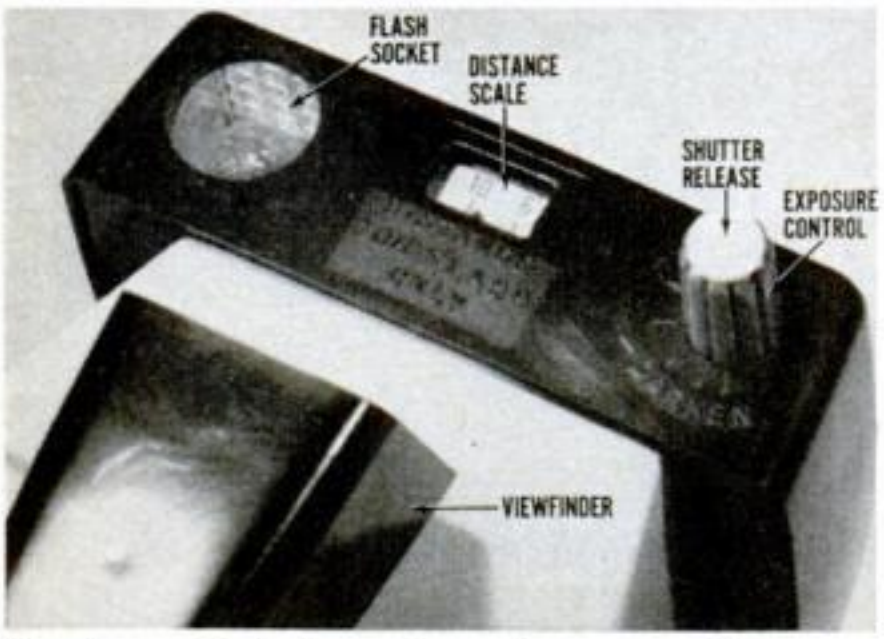
ining. Look at the diaphragm blades in the drawing above. You'll notice that they scissor open or closed as the exposure-control knob is turned, thus controlling the amount of light admitted to both film and light-measuring system.

The light for the measuring system goes through the blades, and on up until it hits a rectangular piece of plastic, the exposure screen. On the lens side of this screen is painted, in black, the word YES. On the other side is painted, in white, NO. Surrounding the NO is a checkerboard of little squares, also white.

Just below and to the rear of the screen is a tiny "grain of wheat" light bulb. Squeeze the control knob and it lights up, shooting a beam of light at the screen.

Now look into the exposure window at the back of the camera. If the diaphragm is not admitting enough light, you see a white NO surrounded by white squares. That's because the *reflected* (bulb) light on the screen is greater than the *transmitted* (outside) light. So you turn the exposure knob to admit more light. But you turn it too far. Now the light from outside overpowers the bulb light. The NO is in silhouette, looking almost black, and all the little white squares have turned black, too.

You turn the exposure knob back slowly. When outside light exactly equals reflected light, the two cancel out. The NO disappears, you see the YES—and you're ready to shoot. ■■



Single control is on top of camera. Exposure-control knob sets distance scale (in center) for flash. Squeezed, it lights bulb for light-measuring system. White button on knob is the shutter release. The flash socket is at the left.

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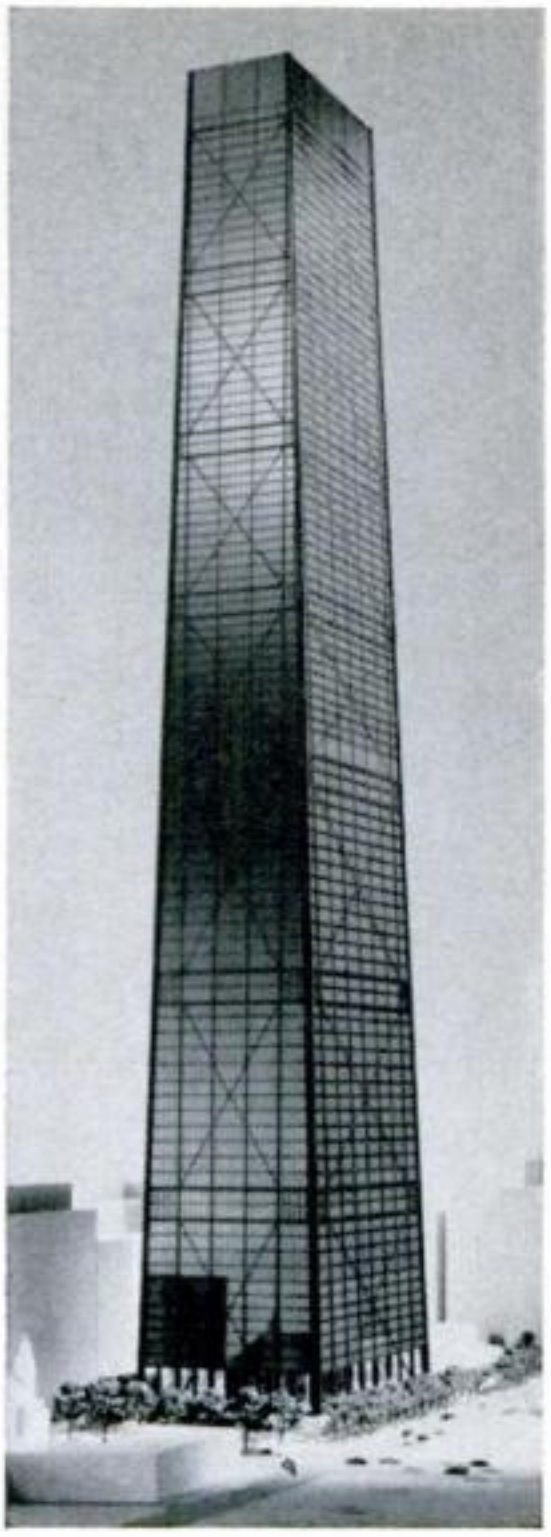
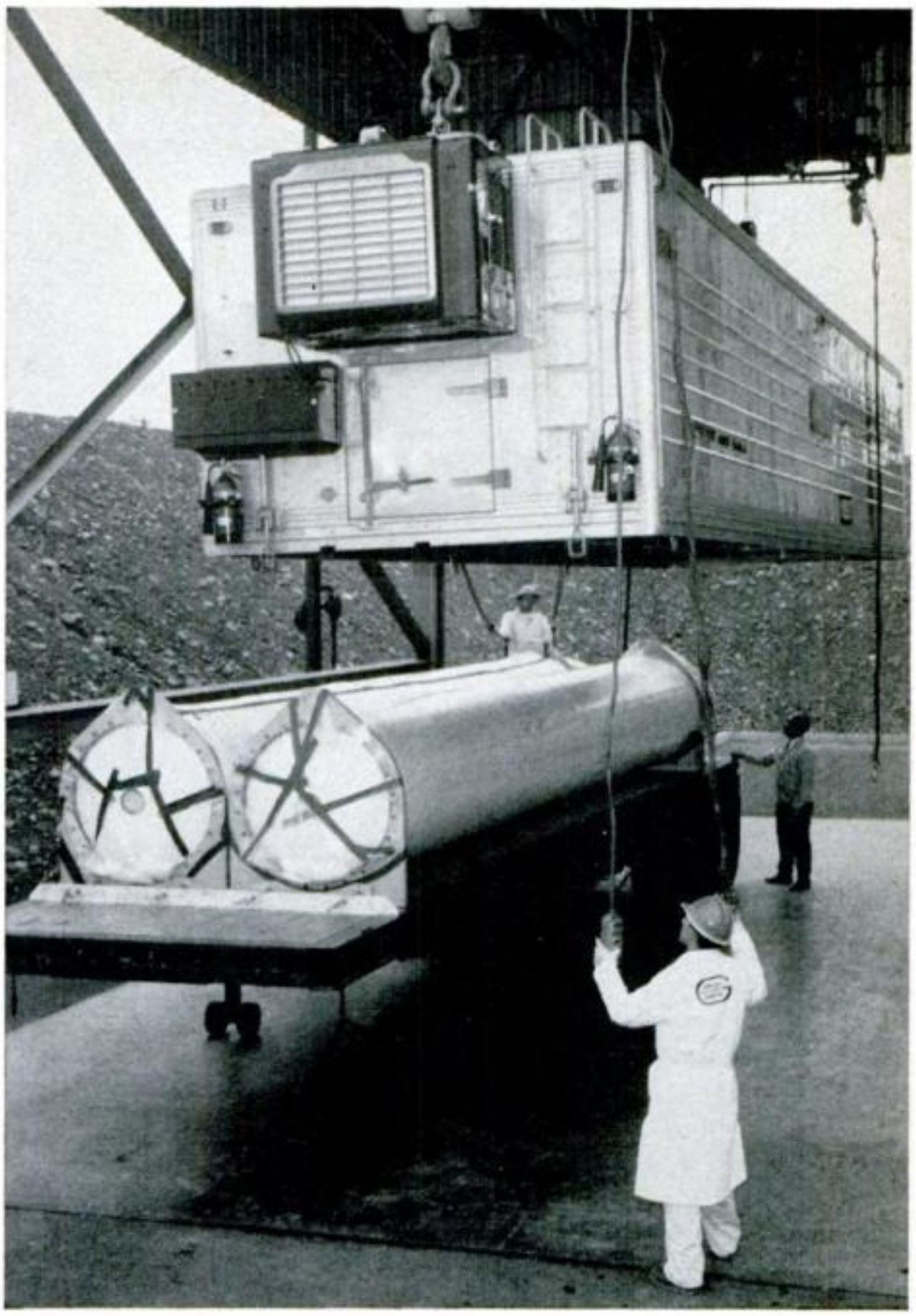


100-story pyramid

With sides tapering up 1,100 feet to its 100-story top, Chicago's John Hancock Center will be the world's tallest residential-and-business building.

Cars will park from the third to tenth floor, offices go up to the 44th. A "sky lobby," apartments, and three-story observatory and restaurant will top the building.



Air-conditioned lid tops rocket trailer

Two big solid-propellant rockets lie side by side on this flatbed trailer for shipment to White Sands Missile Range, N. Mex. The deep-sided top being lowered into place over the trailer contains machinery for maintaining correct heat and humidity during the trip from the Aerojet-General plant in Sacramento, Calif. Attached to a Little Joe II launch vehicle, the boosters will help test an Apollo spacecraft.

Rocket-firing machine gun

Eight rocket-powered shells are fired in rapid succession by a new automatic gun. Weighing 15 pounds and launching 40mm projectiles, the experimental weapon spins its magazine with each shot to put a new shell in the bore. Built by Avco for the Army, the gun speeds rocket case and warhead to the target with no cartridge to eject.

Urheberrechtlich geschütztes Material

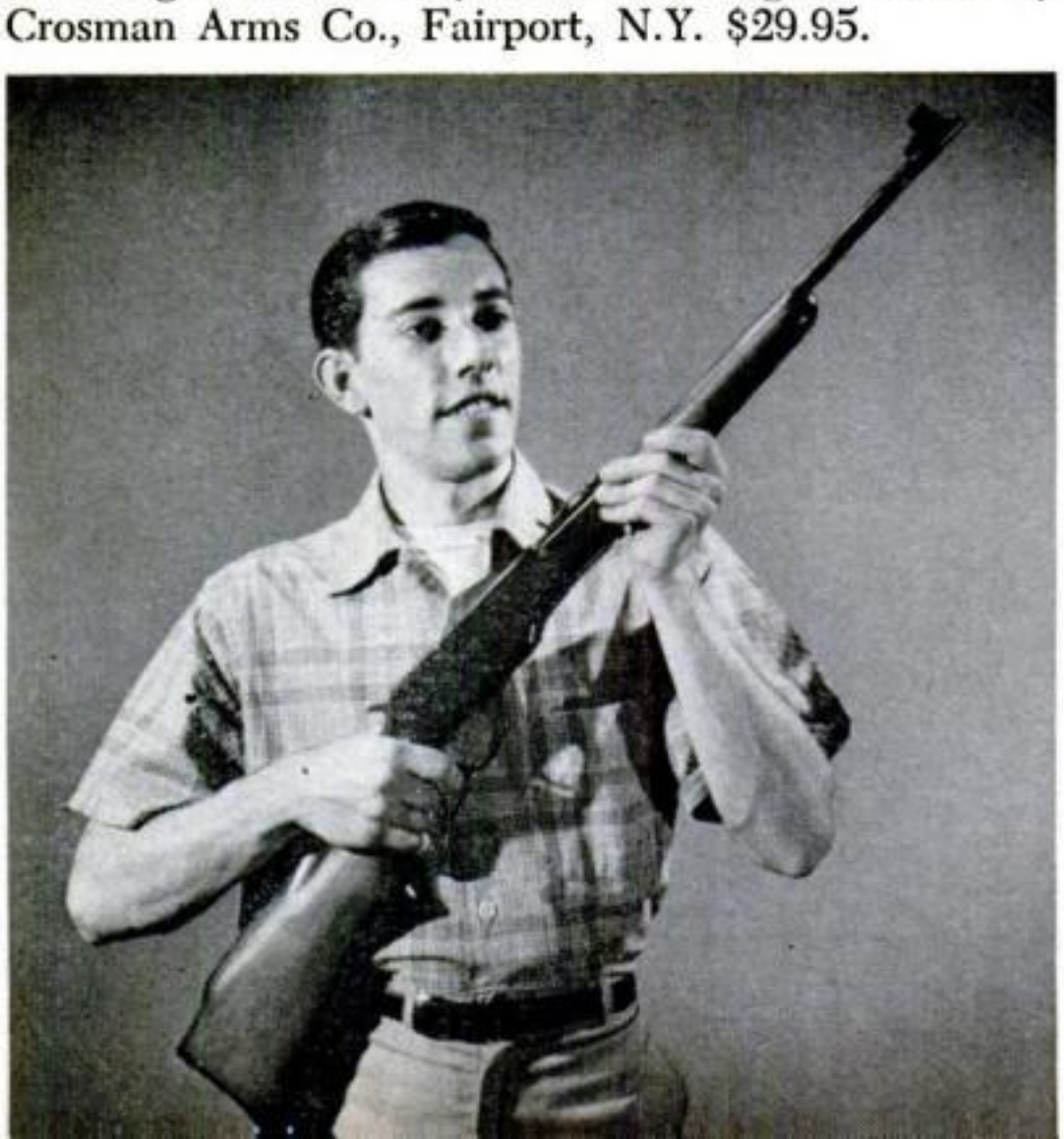
what's new
for the OUTDOORS

Two tents that go up fast and easy

Called the fastest tent in the West—or the East—the new Quon-Quik cottage tent (far right) takes only 10 minutes to convert from two small packages to a 9-by-12-foot Quonset-hut shape with seven-foot headroom. Made of lightweight green twill, it costs $79.50 from R.A. Humphrys' Sons, 1241 Carpenter St., Philadelphia. The two-man Camplete compact sleeper at right uses only a few simple poles and needs no guy ropes. $39.95. Boise Cascade Textile Div., 80 Stonestown, San Francisco.

Man-size lever-action pellet rifle

The size and feel of a real firearm is built into the Crosman 99, a new .22-caliber lever-action pellet rifle. It measures 40 inches, weighs five pounds, 10 ounces, and has a two-stage power selector that can be set for long-distance shots or for short range to conserve CO_2. There is a hooded front sight and an adjustable rear sight. Made by Crosman Arms Co., Fairport, N.Y. $29.95.



Muffler for shooters

On the firing range, or wherever hearing must be protected, you can shut out harmful noise yet hear normal conversation with the new Shooters Muffler. Light and comfortable, it comes apart to fit in a pistol kit. Price, $7.95 from Corcoran, Inc., Stoughton, Mass.

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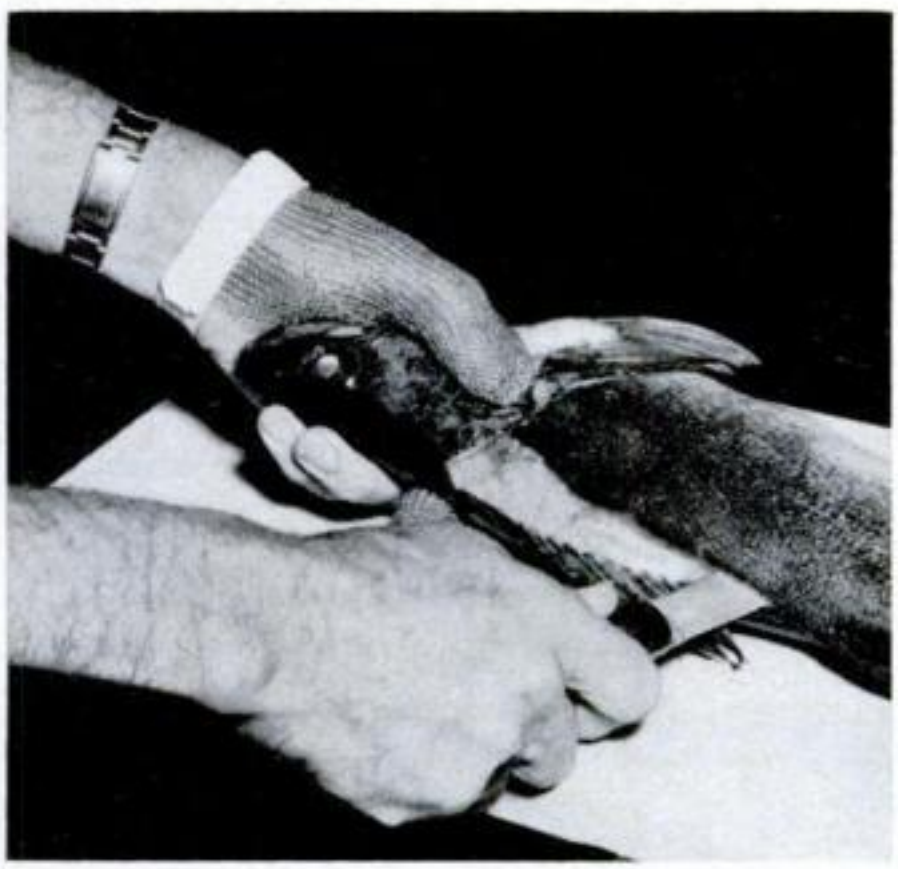

Special glove and knife to fillet fish

A double-mesh, stainless-steel three-fingered glove grips slippery fish and protects your left hand while you fillet fish with a special eight-inch Kabar stainless-steel-coated knife. A guard on the knife keeps your hand from slipping across the blade. Glove, $11.50; knife, $5. Sportsmen's Service, International Falls, Minn.

Vacuum-bottle liner resists breakage

You can eat right out of this wide-mouth vacuum bottle with a metal spoon without fear of breakage. A liner made of a tough polypropylene plastic protects the glass filler. The Hy-Lo jug is available in quart, pint, and 10-ounce sizes at $4.05, $3.25, and $2.65 respectively. Aladdin Industries, 703 Murfreesboro Rd., Nashville, Tenn.

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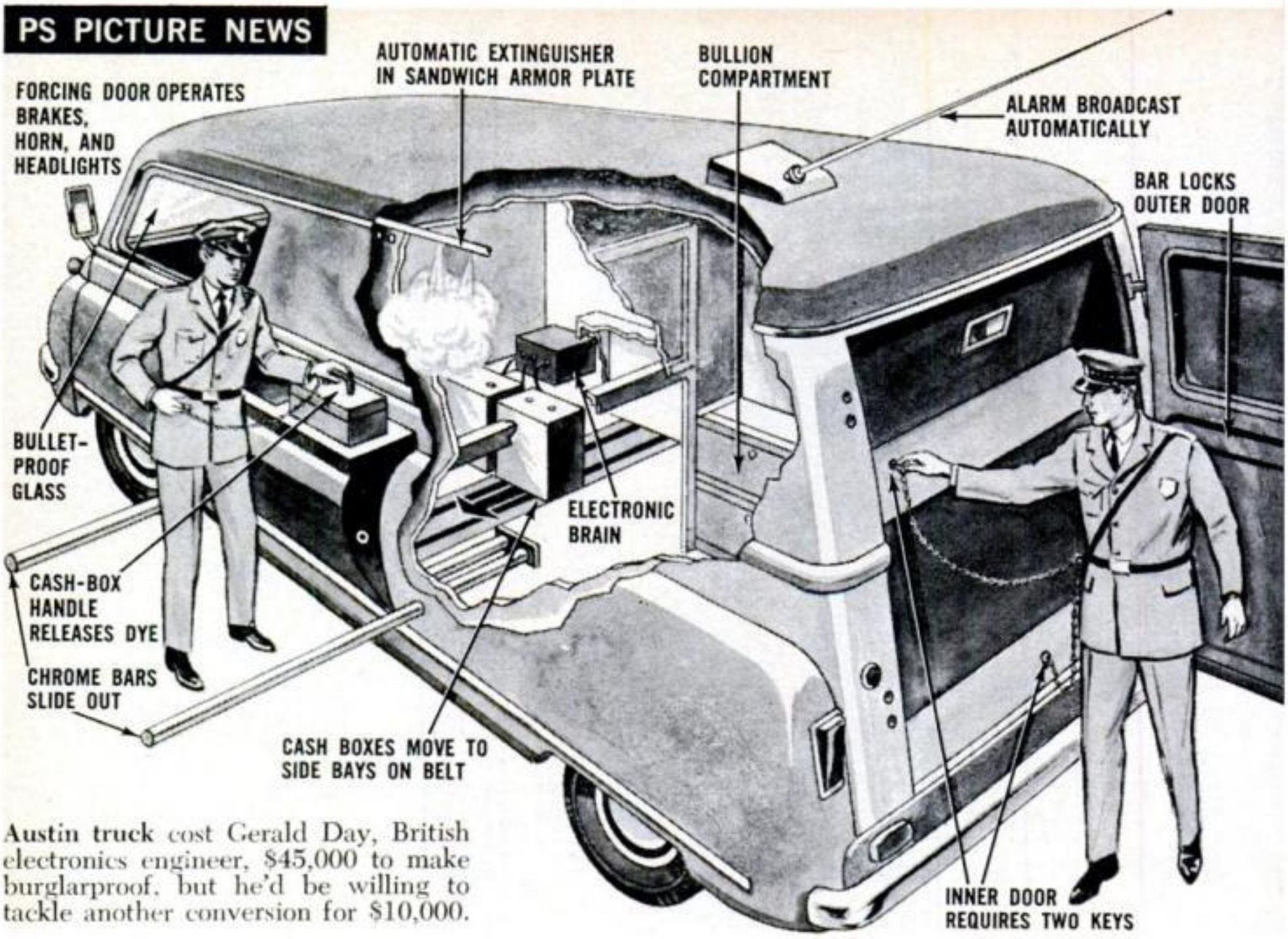
AUTOMATIC EXTINGUISHER IN SANDWICH ARMOR PLATE
BULLION COMPARTMENT
FORCING DOOR OPERATES BRAKES, HORN, AND HEADLIGHTS
ALARM BROADCAST AUTOMATICALLY
BAR LOCKS OUTER DOOR
BULLET-PROOF GLASS
ELECTRONIC BRAIN
CASH-BOX HANDLE RELEASES DYE
CHROME BARS SLIDE OUT
CASH BOXES MOVE TO SIDE BAYS ON BELT
INNER DOOR REQUIRES TWO KEYS

Austin truck cost Gerald Day, British electronics engineer, $45,000 to make burglarproof, but he'd be willing to tackle another conversion for $10,000.

Armored truck battles against bandits

This British armored truck not only is immune to ramming, towing away, or tear-gas attack, it safeguards its cargo even if its crew is overpowered. Cash is carried in 10 boxes on a conveyor that releases them in pairs through bays at the sides. Three switches are operated in sequence to open the bays. Special handles chained to a guard's belt, which contains a secret resistor of the correct ohmic value to retract

Buckets propel swamp excavator

Mobile with no drive to its wheels, the hydraulic excavator at left rides on its buckets. Said to dig equally well in swamps and in rocky land, the excavator is propelled by pushing or pulling with its buckets.

In mud, steel plates are attached under the wheels to keep it from sinking. Swamp-ROC is made by Broyt Mfg. Co., Rockford, Ill. It has a 24-foot boom.

Urheberrechtlich geschütztes Material

Tough steel bars shoot out automatically at the sides of armored car if bandits try to tow it.

Special handles chained to guard's belt are required to lift cash boxes out of bays.

plungers that lock the boxes in, are needed to withdraw them. An attempted break-in jams them. If the guard is assaulted, the circuit is broken and dye is injected to mark the cash. A rear bullion compartment has an inside shutter that drops with a force of 32 tons if disturbed.

Ramming the vehicle locks its doors. Automatic functions include air conditioning to counter tear gas or smoke for six hours, water jets to hinder flame cutters, and a radio transmitter to broadcast an alarm. If robbers try to tow the truck away or push it into a furniture van, its brakes lock and steel bars jut from its sides.

Open bays show lifting arms that raise boxes from conveyor belts for convenience of guards.

Pedals push tricycle wheelbarrow

A pedal-propelled tricycle for British home gardeners has a wheelbarrow hopper mounted in front of its handlebars. The hopper can be tipped forward to unload at the end of its run.

The rear wheel, of 12-inch diameter, has freewheel drive. All tires are semi-solid. It's made by Elswick-Hopper Cycle and Motor Company.

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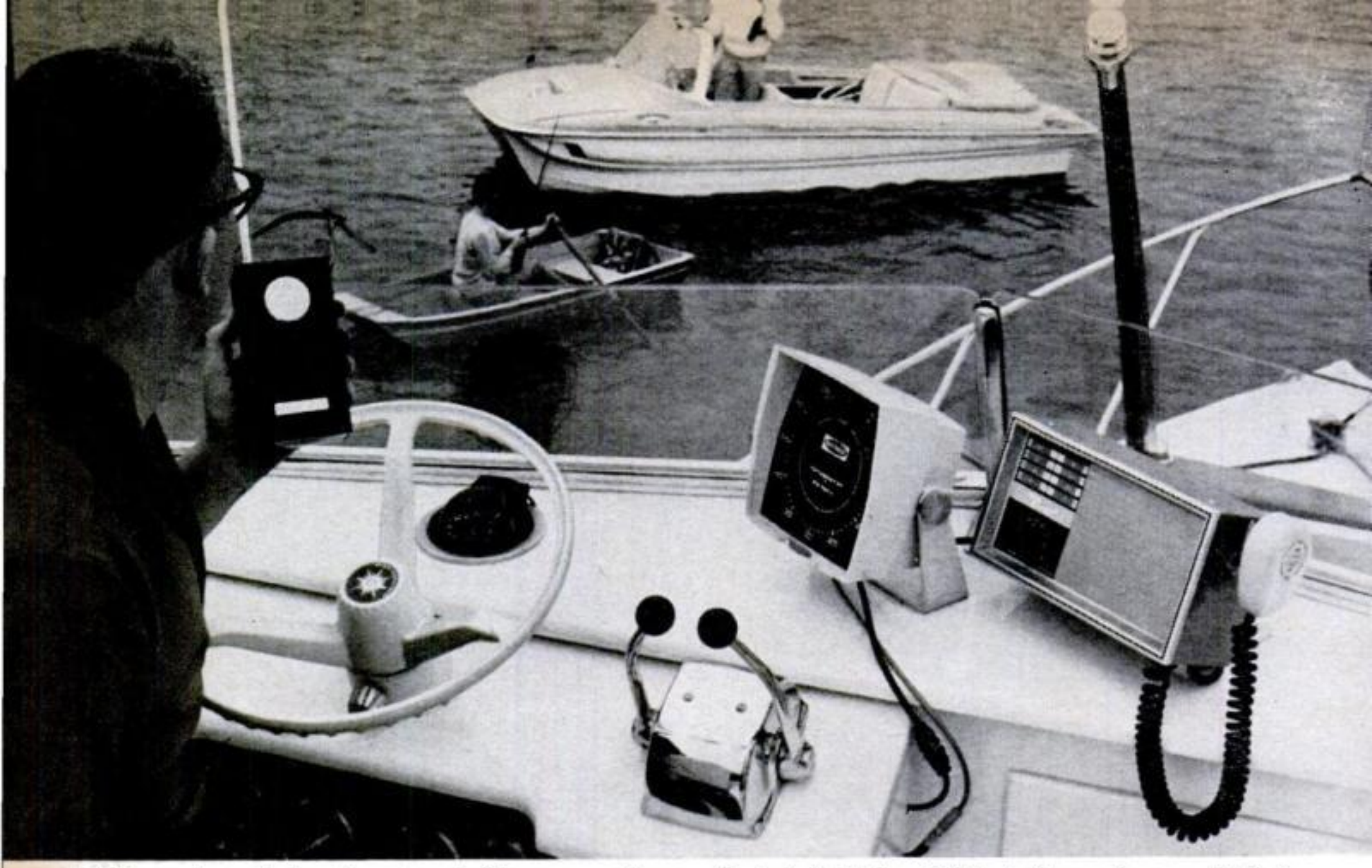

PS marine electronics gear test-team members rendezvous for a last-minute briefing by Boating Editor Jim Roe before setting out to measure the over-water range of CB walkie-talkies. Our test fleet included a 37-foot Pacemaker, a 17-foot Johnson inboard-outboard cruiser, and a nameless eight-foot dinghy. Our testing grounds: the cold (late-spring) waters of Lake Michigan.

PS BOATING

Electronics

PS takes to the water to see how the latest electronic devices add to your fun and safety afloat

By Jim Roe and Ronald M. Benrey

ELECTRONICALLY speaking, our overloaded little dinghy was probably the best-equipped eight-footer ever to venture out into Lake Michigan. She was fitted out with a five-channel radiotelephone, a depth sounder, a loud hailer/foghorn, and a radio direction finder—all powered by a 12-volt storage battery.

Why? To find out if a truly small, small boat can carry a full complement of 1965 "small-boat" communications and navigation gear.

Our conclusion, based on our survey of the small-boat electronics field, was that it can. To get the answers to this and other questions about small-boat gear, PS checked-out a dockful of the latest gear.

We found a new breed of marine electronic instruments: big-boat equipment scaled down in size and tailored in performance to fit family-size craft.

The equipment is compact and light—our dinghy test-proved that—but that's only half the story.

Equally important is that the equipment was designed from scratch for pleasure boats: It's easy to install and child's play to operate, and it's low priced—you can duplicate our dinghy-load of gear for under $600.

As you'd expect, most of the equipment we examined was transistorized. We found that supplying electric power to run it was

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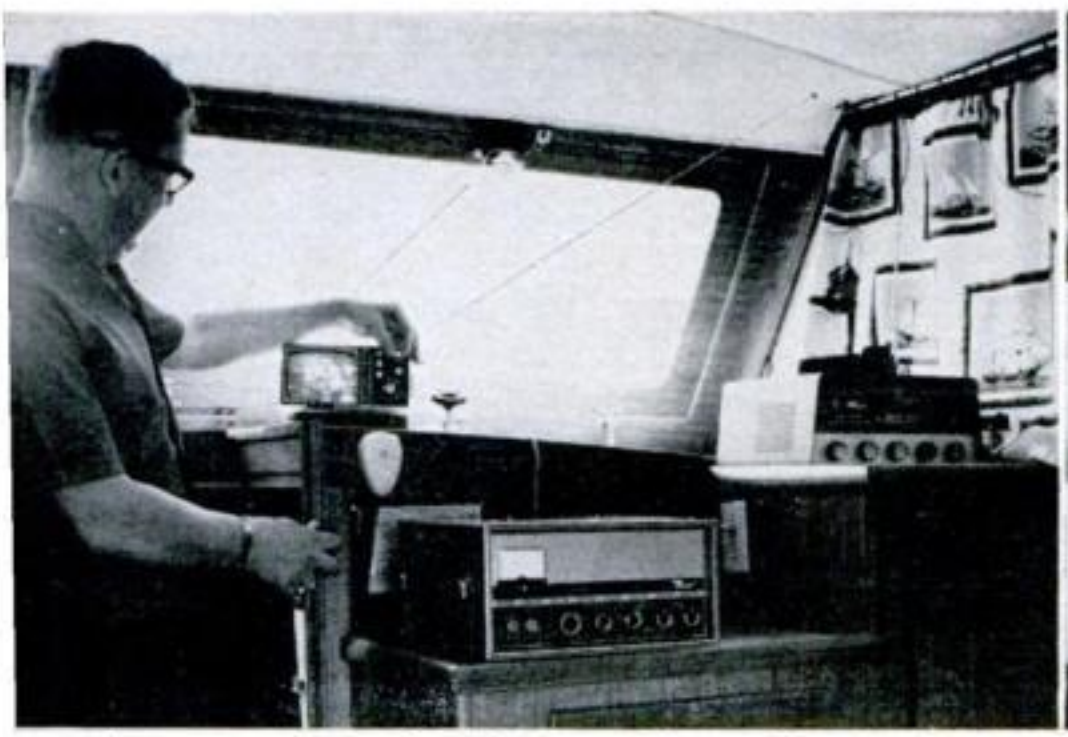
Urheberrechtlich geschütztes Material

Hardest part of mounting a shoebox-size Hartman Hurricane 30-watt radiotelephone in our 17-footer was locating the antenna: It should be close to the radio, out of the direct path of spray, and not interfere with passengers stepping in and out of the boat. Our first-choice spot (above) didn't work: Too many passengers thought the antenna was a handle. Rig costs about $300.



TV in your boat? Sure—if you have time to watch. All of the transistor portables plug into a boat's DC power supply, or run off a rechargeable battery pack. The antenna? Close to shore, the set's built-in whip works fine. Farther out, you'll probably need an external antenna. Forget deep-sea TV unless your boat has a mast on which you can mount a high-gain antenna.

Flit its switch, and this Hartman converter transforms your car radio into a marine-frequency receiver that tunes from 2,000 kc. to 3,000 kc. The battery-powered unit will pick up ship-to-ship and ship-to-shore radio, WWV time signals, Coast Guard weather bulletins. To connect it, just plug it in, in series with the radio's antenna lead. Cost of the converter is $19.95.

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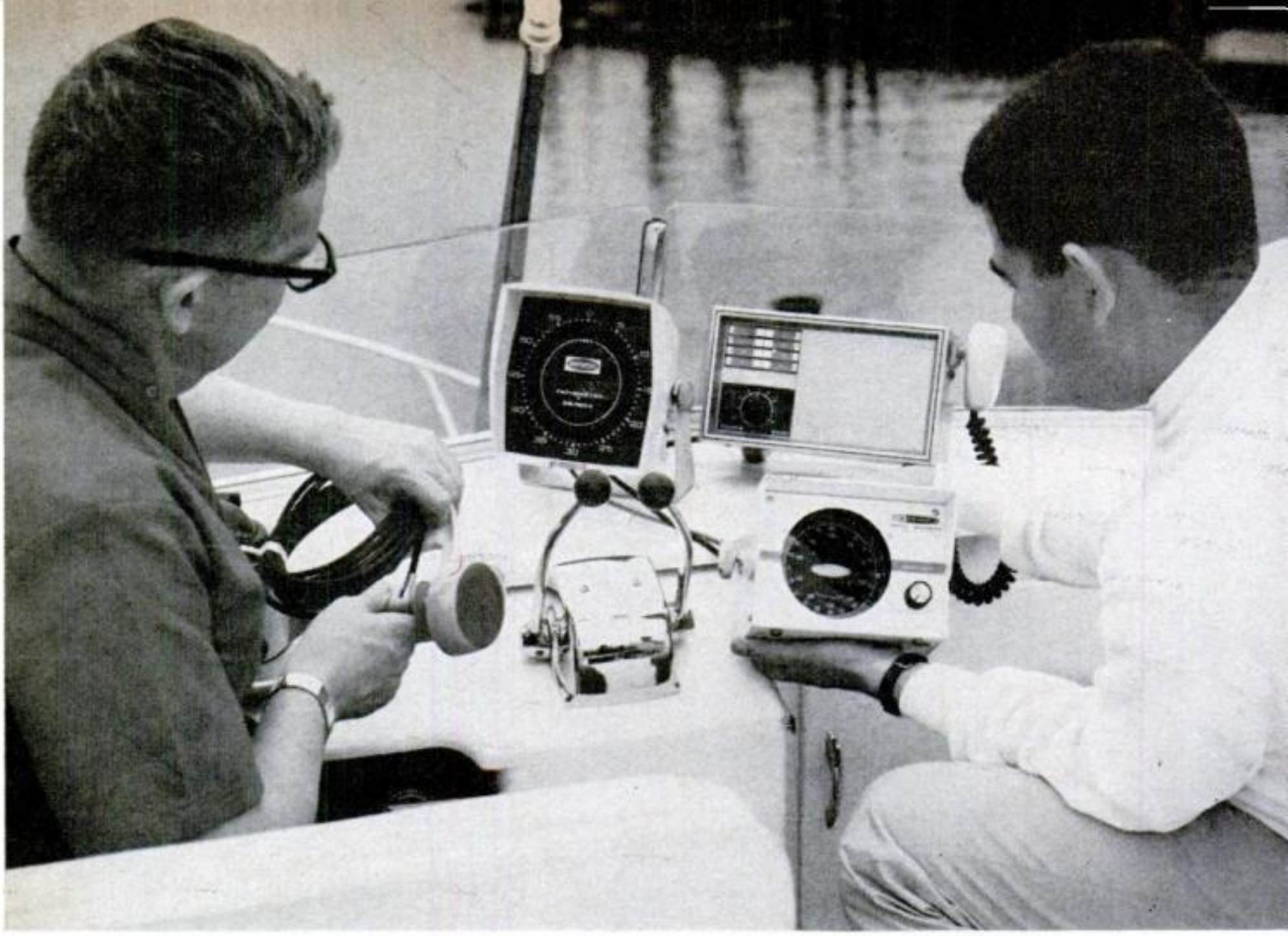

These two depth sounders—Raytheon DE-720A (center) and Heathkit M1-11A (hand-held at right)—are both low-cost echo-sounder units. The similarity ends there. The Raytheon sounder is designed for shallow waters; its dial reads 0 to 60 feet. Depths of five feet or less can be measured accurately, a great help if you cruise a deep-keel craft in shallows with submerged objects. The Heathkit is an all-purpose sounder that will measure down to 200 feet. It can be used on the smallest boats, it's light enough to be hand-held, and it runs on built-in batteries.

an easy job, even on the smallest boats. If your boat has an available on-board source of 12-volt DC (required by most units), you can simply plug the equipment in. If not, bring along a marine storage battery when you cruise; one charge will power a boatload of gear—including a radiotelephone—all day.

What's available? Check your local marine-equipment dealer, and you'll find small-boat versions of all the traditional big-boat communications, navigation, engine-control, and safety items. In fact, most of the equipment is manufactured by well-known big-boat electronics firms.

But don't stop there. Have you considered buying marine-electronics gear in money-saving, ready-to-wire, kit form? If you're willing to wield a soldering iron for eight hours, for example, you will wind up with a high-quality depth sounder, and save about $30.

You'll see still more small-boat electronics—but incognito this time—at your local radio-TV dealer. Any of the new transistorized TV sets, and many portable hi-fi systems, will be happy aboard your boat.

What gear for your boat? Most small-boat owners agree on one point: A radio direction finder (RDF) is a necessity if you cruise out of sight of shore. Chances are, several other types of modern small-boat electronic equipment will make the kind of boating you do safer and more fun. Here's a rundown on a few you may not have considered:

Radiotelephone. Is it a luxury? Many small-boat owners who cruise in coastal and Great Lakes waters think so. Actually, first and foremost, a radiotelephone is a safety device. In an emergency, it gives you the means of calling for help, fast—from the Coast Guard, nearby ships, and coastal ship-telephone stations.

Under more pleasant circumstances, you can use your radiophone to:

- Communicate with other boats over the ship-to-ship operating frequencies.

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RDF-equipped transistor portable radio, like this Zenith Super-Navigator, is lightweight insurance against getting lost. Although it's not a precision navigation instrument, you can usually find your position with enough accuracy to choose a heading that will get you home.

Called a Fish-Point "fish-finder," this is actually a portable depth sounder. Fish show up on the dial as weak extra readings between zero depth and the true bottom-depth reading because their internal air-filled bladders reflect sound waves. It costs $100. Murray Industries, Bellevue, Wash.

- Talk with almost any telephone in the world via a ship-to-shore connection through a costal telephone station.
- Monitor broadcast weather bulletins on the ship-to-shore bands.
- Request a navigational fix from a Coast Guard shore station.

The point is, a radiotelephone is as necessary as a rudder on any boat—regardless of size—that has the power and range to cruise in Coast Guard-patrolled waters.

Prices of a complete small-boat installation, including antenna and grounding systems, start at about $200. The lowest-cost units have 25- to 40-watt transmitters, giving them an effective operating range of about 30 miles.

What about CB radio? Citizens Band radio is not a substitute for marine radiotelephone. There are three reasons:

- The 27 CB operating channels aren't monitored by the Coast Guard, or any other full-time observers, so you can't be sure someone is listening if you make a distress call—and that's not security enough.
- CB radio can't be used to place ship-to-shore telephone calls.
- The five-watt transmitter power ceiling set by the Federal Communications Commission limits the reliable operating range to about 10 to 15 miles.

On the other hand, we found that CB radio can be as useful as an extra crew member when it's used as an auxiliary two-way radio system: Five-watt transceivers are ideal for "home-to-boat" communications on lakes and protected inland waters; hand-held low-power walkie-talkies—with overwater ranges of about one mile—are perfect for short-range boat-to-boat and boat-to-dock transmissions.

Depth sounder. This handy device wears three hats:

- Navigation aid—use it to find your position in a charted channel by matching the sounder's depth readings with known values printed on the chart.
- Underwater lookout—it will warn of

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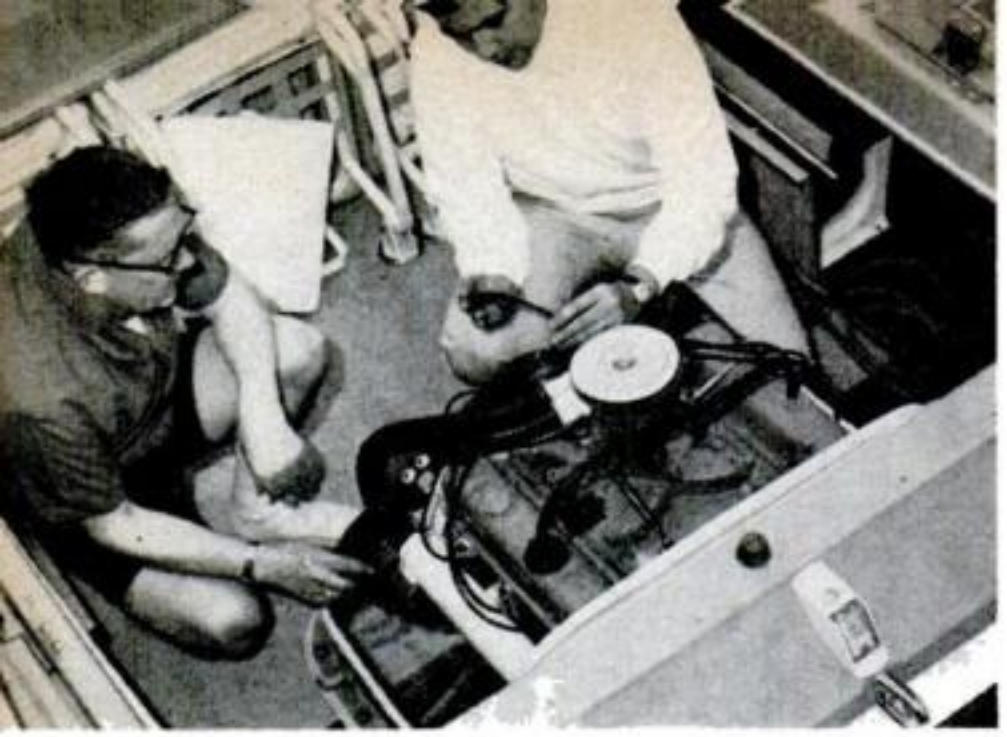
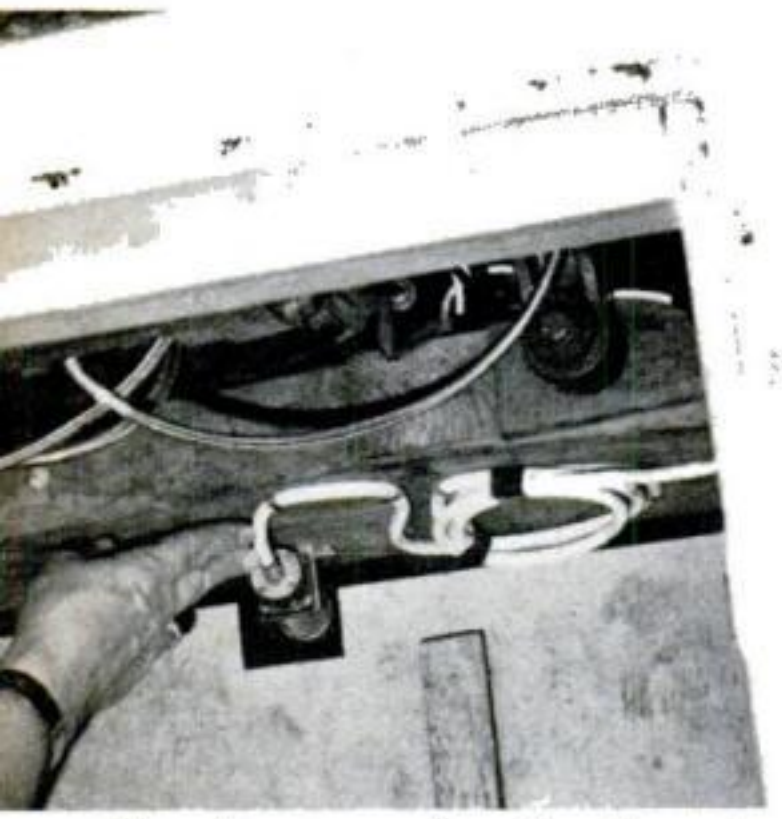
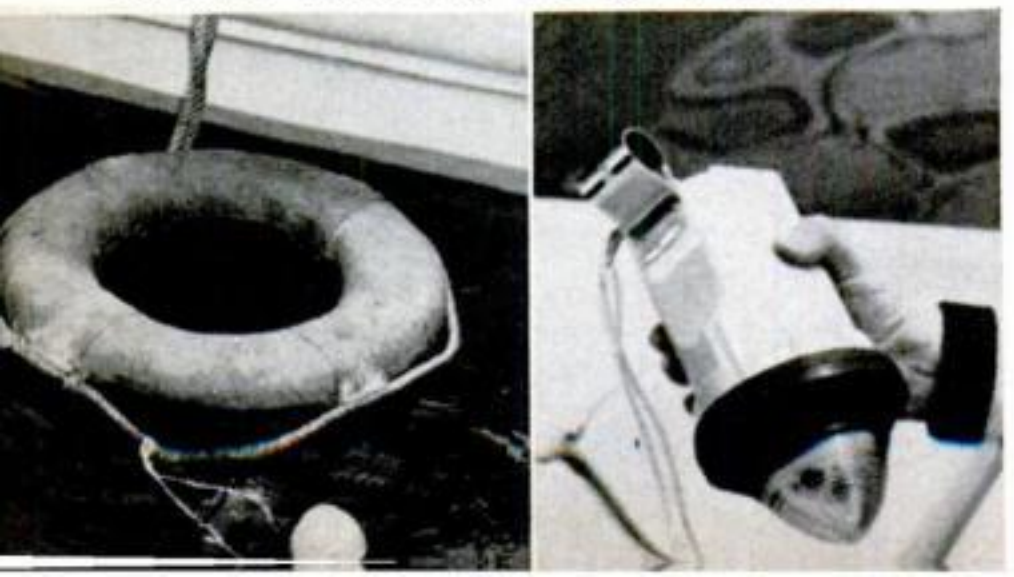


Ignition-caused radio interference is usually worse on boats than cars: Marine engines aren't surrounded by a static-shielding steel body. If it's a problem on your boat, try the simple remedies—such as resistance spark-plug cables and generator-noise suppressers—first. If they don't do the job, intall a shielding kit on the engine's complete electrical system.



Gas fumes are heavier than air—they fill a closed area from the bottom up—so the best location for a fuel-vapor-detector sensing element is the lowest point in an engine compartment (above). Think only big inboard cruisers need one? A gas-line leak can cause explosive vapors to build up under the engine shroud of an inboard-outboard, or in an outboard's bilge.

Pint-sized Guest flashing buoy clips on to any life preserver's line. Its brilliant flash is visible for miles at night. Inside, there's a transistorized circuit similar to a photographic strobe light. You stow the battery-powered lantern upside down: when it hits the water, it automatically rights itself, and a built-in mercury switch starts the flash—which may one day save a life.



submerged hazards when you cruise unfamiliar waters or shallows.

● Fish-finder—it can pinpoint the depth of large individual fish or schools of small ones.

A small-boat sounder consists of a transducer (mounted beneath the hull) and an indicator (mounted so the boat's pilot or chief fisherman can see it). It operates in much the same way as a Navy sonar unit.

About 20 times each second, the transducer generates a short burst of ultrasonic sound waves—at too high a frequency to be heard—and beams them down thorugh the water.

When the waves hit bottom, they are reflected upwards—the transducer "hears" an echo of its original burst a fraction of a second after it generates it.

The length of the tiny time delay between the instant the transducer generates the burst and the instant it hears the echo is proportional to the water's depth—the deeper the water, the longer the time delay.

The indicator's circuitry measures the delay and converts it into an equivalent depth reading, which is displayed on a calibrated dial or meter. Depth-sounder prices start at about $70.

Fuel-vapor detector. If there's a possibility of gasoline vapors building up in a poorly ventilated area near the engine, a detector is a necessity on your boat. Gas vapors are highly explosive—the fumes from one cup of gas pack as much destructive wallop as 15 sticks of dynamite—and a spark from electrical machinery, or a hot metal surface on a running engine, can ignite them. The detector's sensing element contains a red-hot glowing platinum wire surrounded by a cylindrical screen made of metal mesh. The screen prevents the hot wire from igniting vapors outside the sensing element. Air circulates around and through the element, and any combustible vapors that get inside the mesh cylinder are ignited by the filament.

As they burn, the heat given off raises the platinum wire's temperature and changes its electrical resistance. A simple electronic bridge circuit monitors the varying resistance value—the greater the change, the greater the vapor concentration.

All detectors have a meter that indicates when the vapor concentration reaches the danger point; a few have an audible alarm in addition. Prices start at about $40. ■ ■

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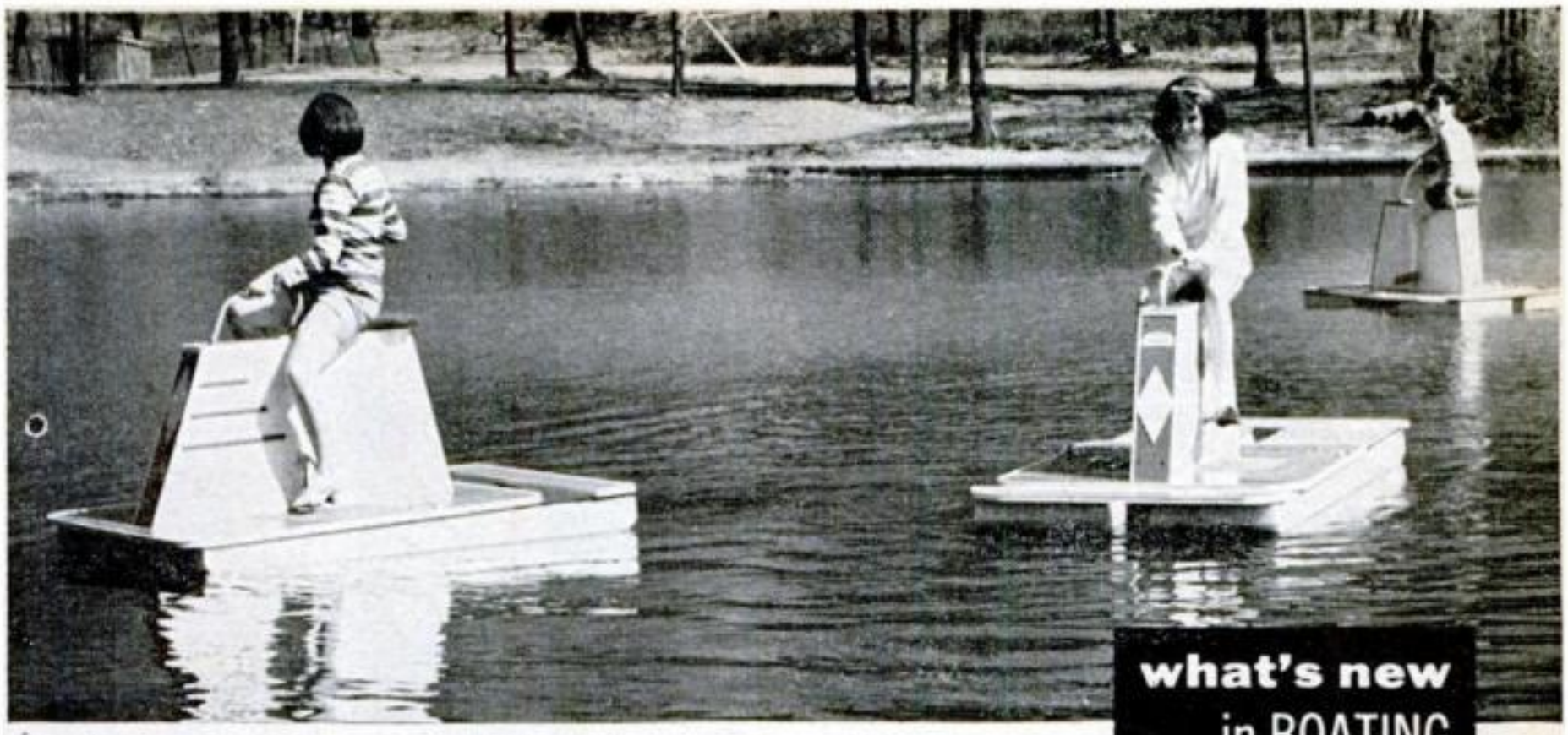


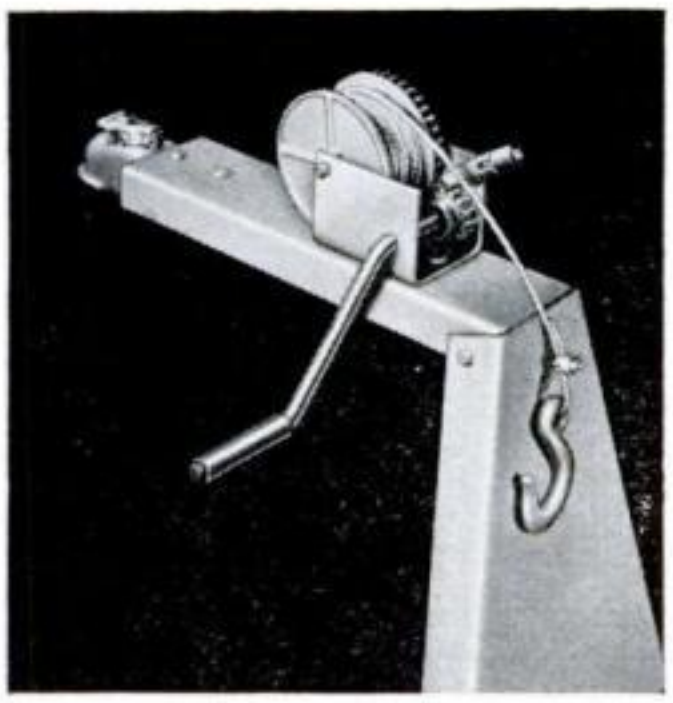
what's new in BOATING

Lightweight water bike is made of foam

These compact water bikes can hold four adults or six youngsters—up to 750 pounds—on their 4½-by-4-foot decks. The bikes have direct drive and rudder steering, eliminating gears, pulleys, and cables. They're made of foam plastic, resist swamping and tipping. Price: $249. Lomma Enterprises, 305 Cherry St., Scranton, Pa.

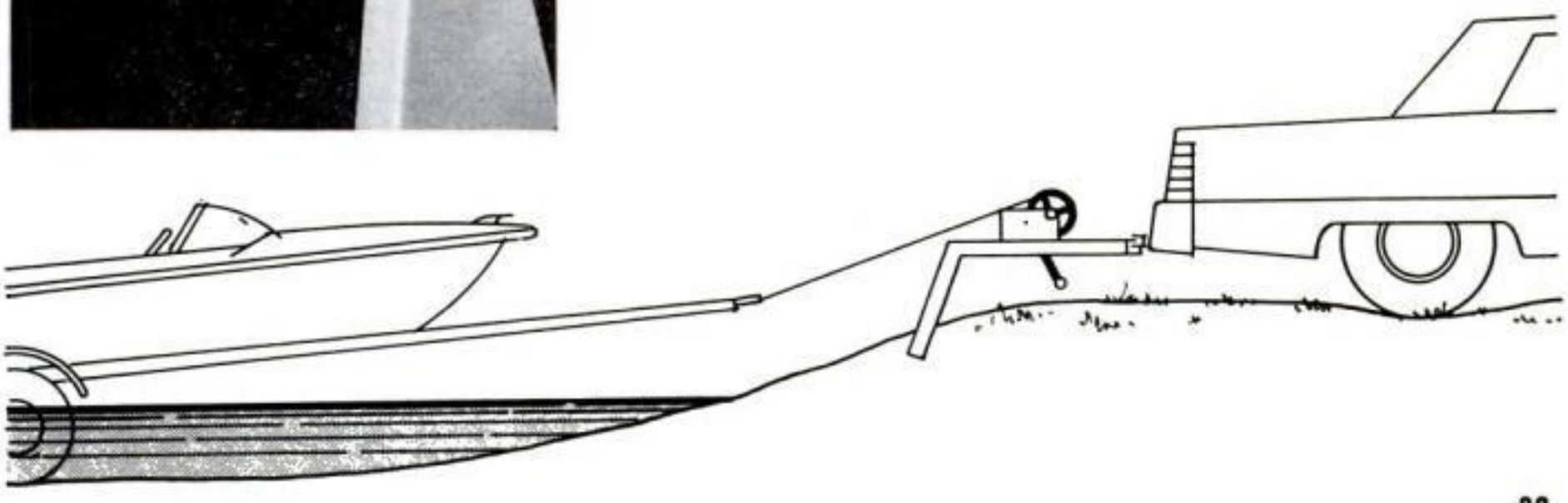
Boating self-taught in one book

You can teach yourself seamanship, safety, navigation, and other vital boating subjects with this correspondence course. Each subject builds, like blocks, upon the other. A special sliding-mask device helps you check your written answers. Price is $19.95 including final exam from Weems System of Navigation, Annapolis, Md.



Winch for remote launch and recovery

Here's a handy winch for launching or retrieving your boat in steep or muddy areas while your car sits high and dry on safe ground. The Launch-Aid has 50 feet of 4,200-pound aircraft cable, and attaches to a standard trailer ball. A deluxe model comes with 100 feet of cable. The device folds for trunk storage. Hoggren Truck & Auto Service, 8556 So. Carpenter St., Chicago 60620.



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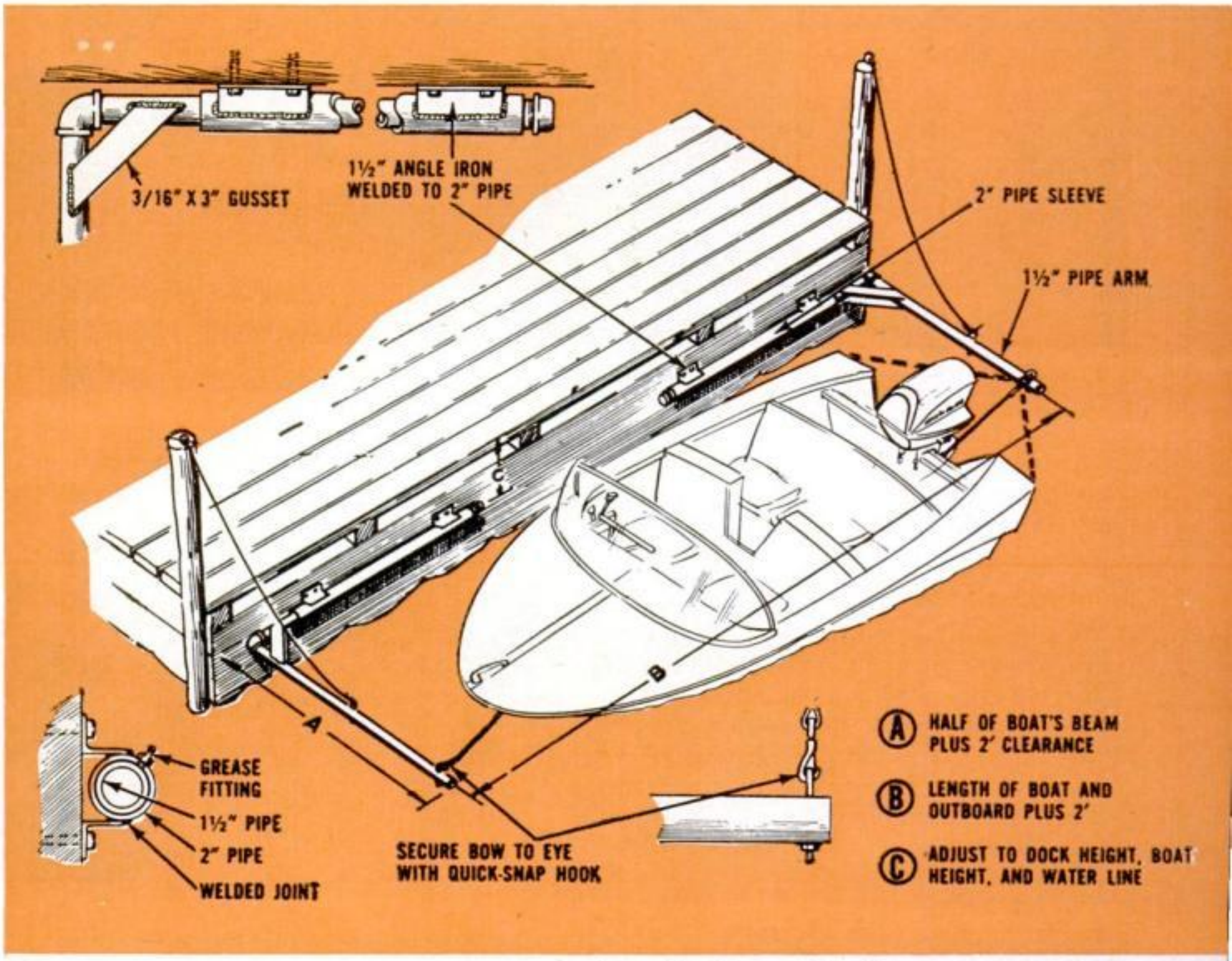
PS BOATING

Boating Ideas


3/16" X 3" GUSSET
1½" ANGLE IRON WELDED TO 2" PIPE
2" PIPE SLEEVE
1½" PIPE ARM
GREASE FITTING
1½" PIPE
2" PIPE
WELDED JOINT
SECURE BOW TO EYE WITH QUICK-SNAP HOOK
A
B
C
A HALF OF BOAT'S BEAM PLUS 2' CLEARANCE
B LENGTH OF BOAT AND OUTBOARD PLUS 2'
C ADJUST TO DOCK HEIGHT, BOAT HEIGHT, AND WATER LINE

Bump-proof docking rig for your boat

Here's a snug docking device that will let your boat ride out any storm. Sturdy 1½-inch-pipe arms cradle your craft and hold it securely while keeping it from rocking into the dock. Use elbows to form a right angle at the dock end of the arms and weld steel-plate gussets across the elbow-bend area for added strength. The arms pivot in two-inch pipes fastened to the dock with six-inch lengths of angle iron. Drill and tap the sleeve ends for grease fittings; an occasional shot of grease will keep them free of rust.

Mount the arms high enough to clear smaller waves and with a spread to clear your boat 12 to 18 inches fore and aft. They should extend about two feet past the boat's centerline. Use a nylon or other flexible line to tether the arms to the dock and keep them from dropping into the water when you cast off. It must be long enough not to interfere with the arm's downswing as it follows the pitch of the docked boat.

Use longer arms if tides complicate your mooring.—*Henry Clark.*

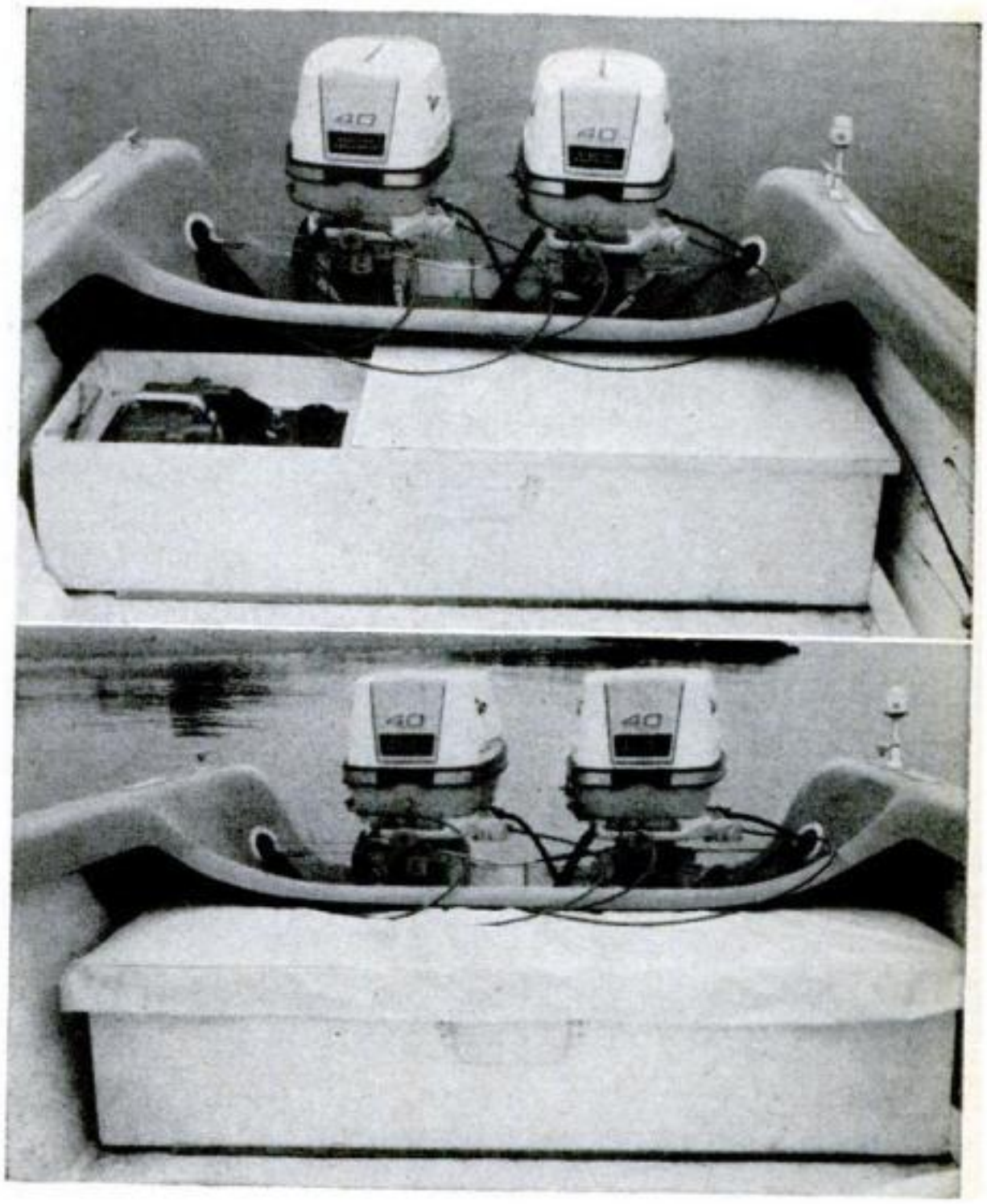
Urheberrechtlich geschütztes Material

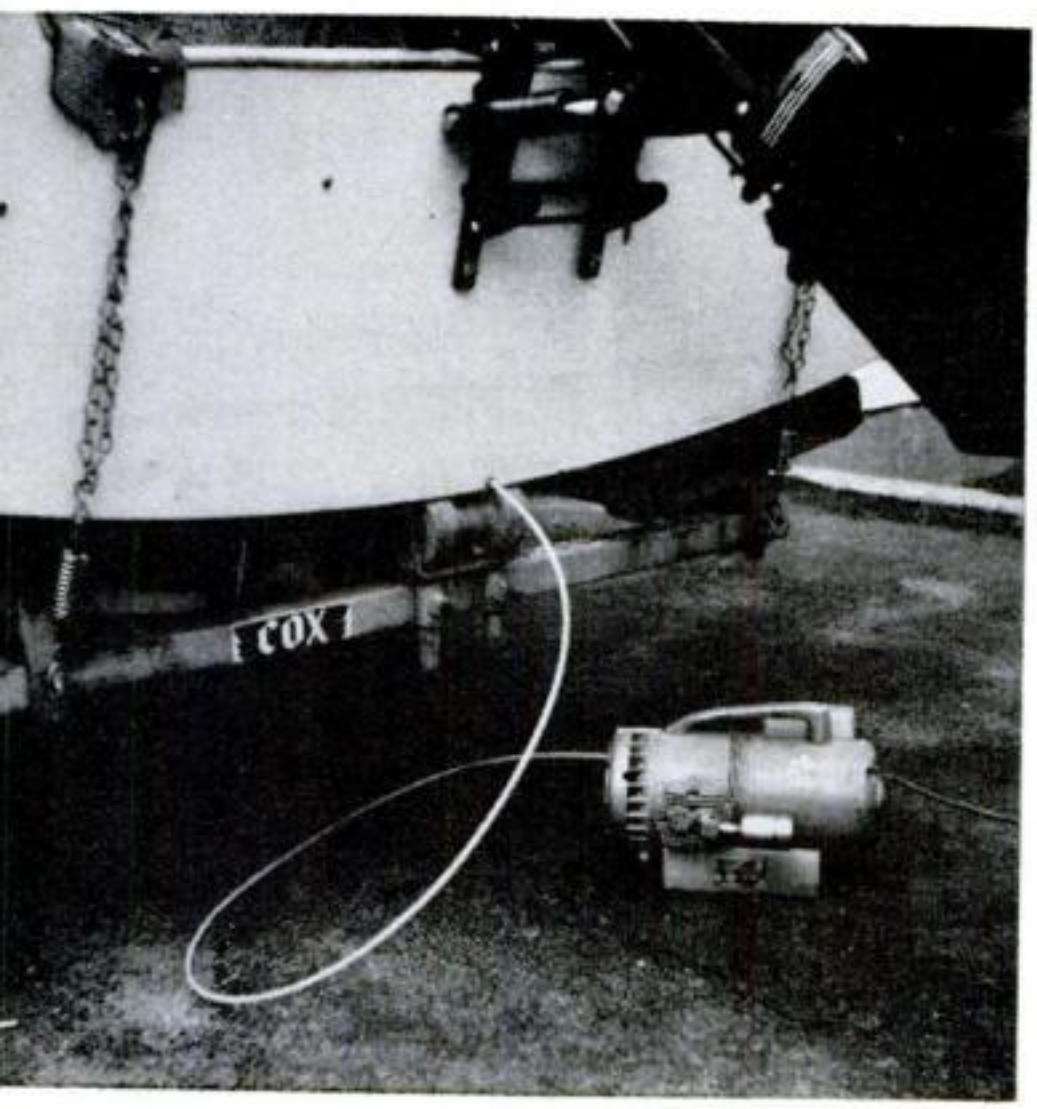
from PS Readers

Extra seat makes a home for roving fuel tank

I found a neat way to end the shifting and rusting of fuel tanks in rough seas and salt water—and gained seating space as a bonus.

I traded my two 12-gallon tanks for one 24-gallon one, and built an enclosure the width of the boat. Of ¾" exterior plywood topped with ⅜" plywood, this big compartment is partitioned off to hold the battery, too. To ensure good ventilation, I left the back open, braced with a crosspiece. The lid of the seat is cut in two so the whole thing doesn't have to be lifted off for refueling. Over the four-inch-high tank is a shelf for storing charts, first-aid kit, and fishing tackle. Cushions make the seat comfortable for trolling or drifting for flounder—or for just sitting and sunning yourself. *—D. B. Stuart.*





Bubbles locate holes in fiberglass hulls

Want an easy way to find leaks in a double-hulled fiberglass boat? Use Junior's soap-bubble liquid. Open the drain plug and insert the hose of a small air compressor. Start the compressor and apply the soap solution with a paintbrush where you suspect a leak. Mark the spot where bubbles appear. Then scrape the area from the floor up. Put a heavy coat of resin over it and repaint.—*Jack Payne.*

Urheberrechtlich geschütztes Material

Author drives a British-built Dodge truck equipped with differential diesel engine.

More Pull at Lower Revs

New supercharged diesel acts like a steam engine

By David Scott

AUTO engineers often muse fondly over the steam engine, in many ways an ideal traction machine because it gives maximum torque at zero revs and constant power throughout the speed range, and sidesteps transmission headaches. Now Perkins Engines Ltd., in England, has come up with the nearest thing yet in an internal-combustion engine—a differentially supercharged diesel.

This unique power system nearly doubles the work capacity of an ordinary truck engine, boosts output at low revs so engine speed and wear are reduced, and eliminates gear shifting in the bargain. As a bonus, in terms of cost and weight, it's something for nothing.

High-powered diesel engines are often too heavy for automotive use. Superchargers, and more recently turbosuperchargers, have become effective weapons in the war on weight. But in both cases the horses are added at the top end of the speed range (boost pressure and volumetric efficiency rise with the speed of the blower). There is little improve-

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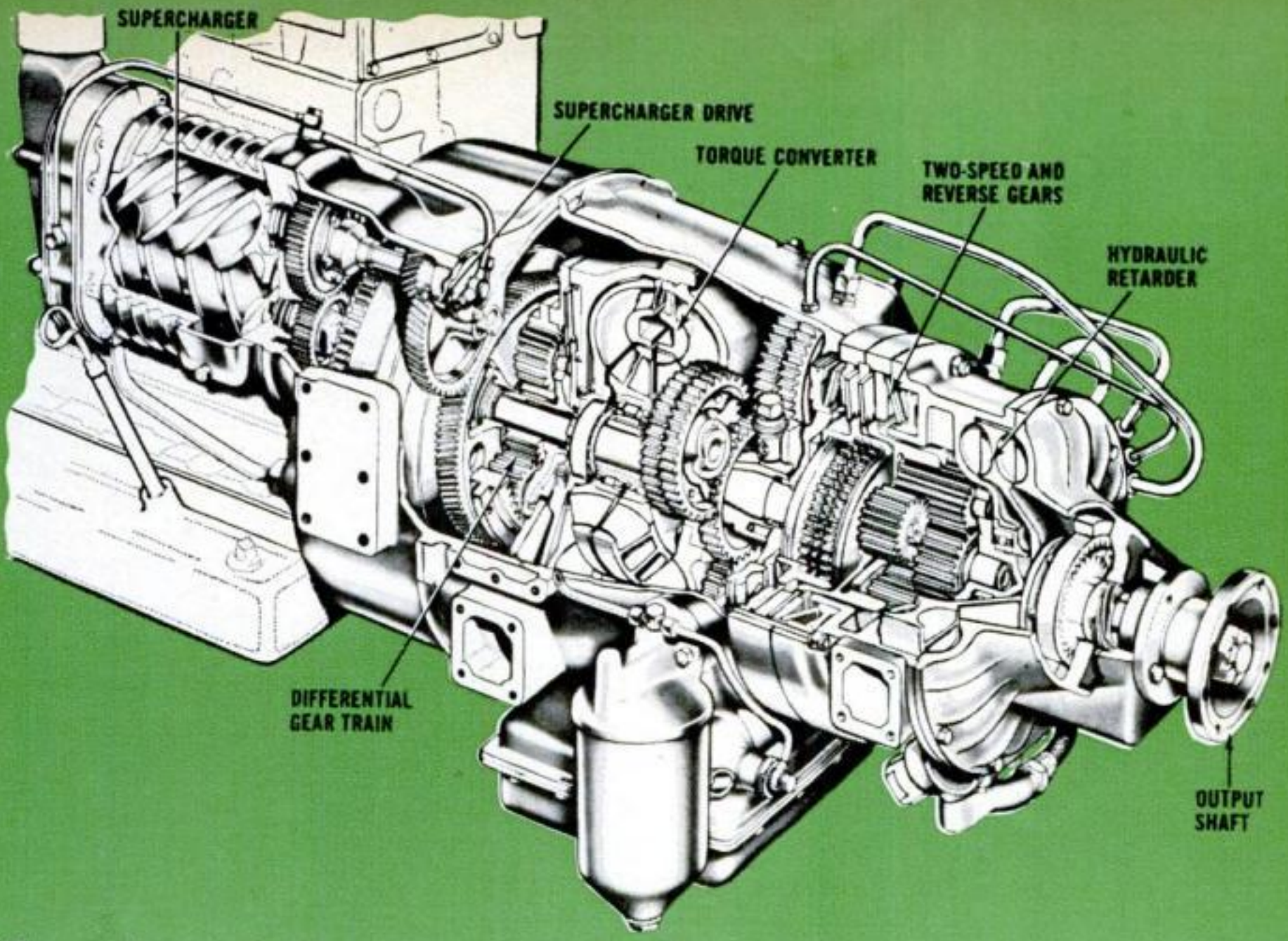
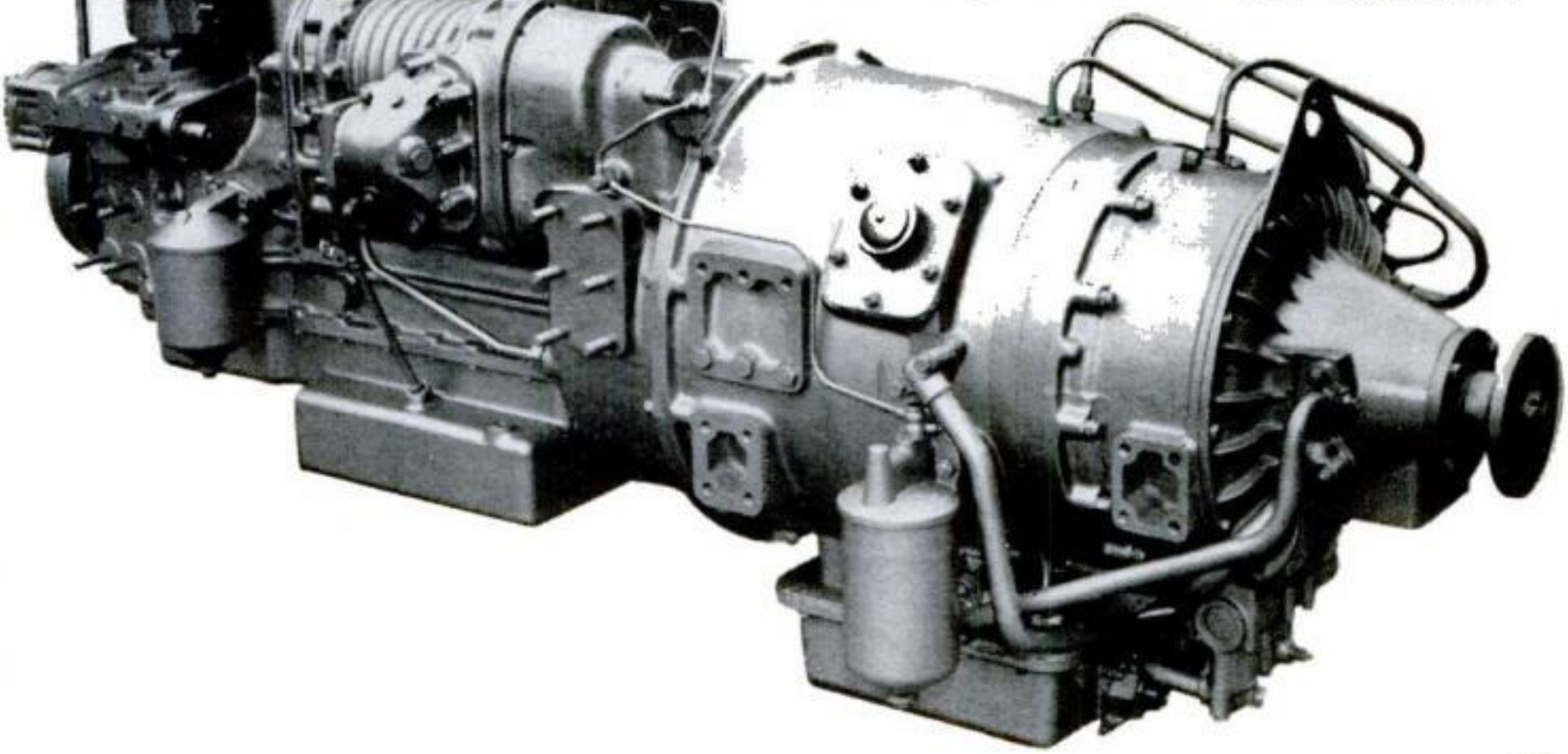


The machinery of differential supercharging consists of a planetary differential gear interposed between the engine and the output shaft, with the engine driving the planet carrier. The rotary-screw compressor is driven by a third member of the differential. The compressor senses torque requirements and automatically boosts air intake to **step up the output.**

Six-cylinder direct-injection four-stroke 354-cu.-in. Perkins diesel engine develops 120 hp. at 2,800 revolutions without supercharging. A differential blower raises output to 160 hp. and gives 60-percent higher torque. Peak power is developed at an incredibly low 1,400 r.p.m.



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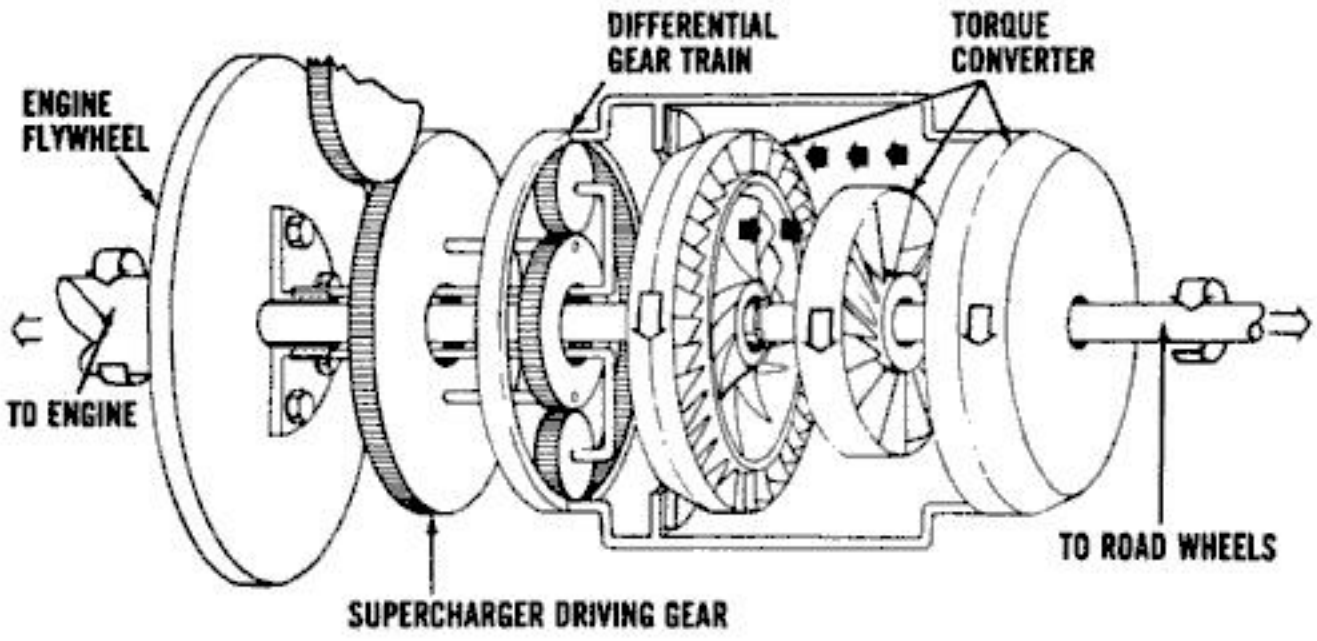
Differential diesel may be the truck engine of the future



Differential gear train acts as a three-way torque divider. The output shaft is driven by the annulus, and a sun wheel drives the blower via a step-up train of gears. The system balances torque—it is not a speed-dividing differential. Input torque to any member is divided in constant proportion between the other two members. Speed variations depend on the torque reactions at each shaft at any given moment.

ment in the low-down torque that's needed for getaway and hills.

The Perkins rig does just the opposite: Supercharge boost and output torque increase when revs drop. This is achieved by a unique differential drive for the supercharger. A planetary gear train interposed between the engine and the output shaft acts as a variable torque divider and enables the compressor to sense how much torque is needed.

Max torque at low r.p.m. When starting from rest, the stationary wheels brake the output member of the gear train. This causes the blower to wind up to full pressure so that the engine delivers maximum power as low down as 1,400 r.p.m.—halfway up its speed range. Pressure drops gradually during acceleration, but engine speed remains almost constant because less torque at the wheels is needed as the vehicle picks up speed.

The transmission is fully automatic, with a hydraulic torque converter incorporating a lock-up clutch and a two-speed planetary gearbox (with emergency low and reverse). The system is immune to overloading and abuse.

Driving the "differential diesel" is kid stuff. I drove a hefty three-axle Dodge loaded with 13 tons of concrete blocks as ballast to make a total weight of 40,000 pounds. I was told: "Put the transmission lever in High and keep your foot down until you reach cruising speed."

Flipping the lever from N to H, I floored the accelerator. Our 20 tons moved away under full steam, but the tach said only 1,500 r.p.m. The blower whine slid down the pitch scale as we gathered speed, but the engine speed did not change. That was the differential doing its job. Drive ratios changed imperceptibly according to torque requirements.

Speed and revs dropped when we reached a 12½-percent grade. I put my foot down hard, the whine built up again while the tach steadied at 1,500, and we hustled up the hill. My cross-country run showed that the differential diesel is capable of extremely high average speeds, because of its power reserve for hills and for acceleration. And it certainly takes the work out of driving a heavy truck.

The complete power plant is smaller and lighter than a standard diesel engine with a five-speed transmission, and production costs will be lower. The standard truck would probably also have a two-speed rear axle (which the Perkins doesn't need)—making the cost difference substantial. With Low range, the differential diesel can tackle anything a two-speed axle could do for 160 hp. Fuel economy is far superior in the Perkins, because high torque is used only when needed.

As the world's largest maker of automotive diesels, Perkins should have the know-how to make this slick design a successful business proposition. ■■

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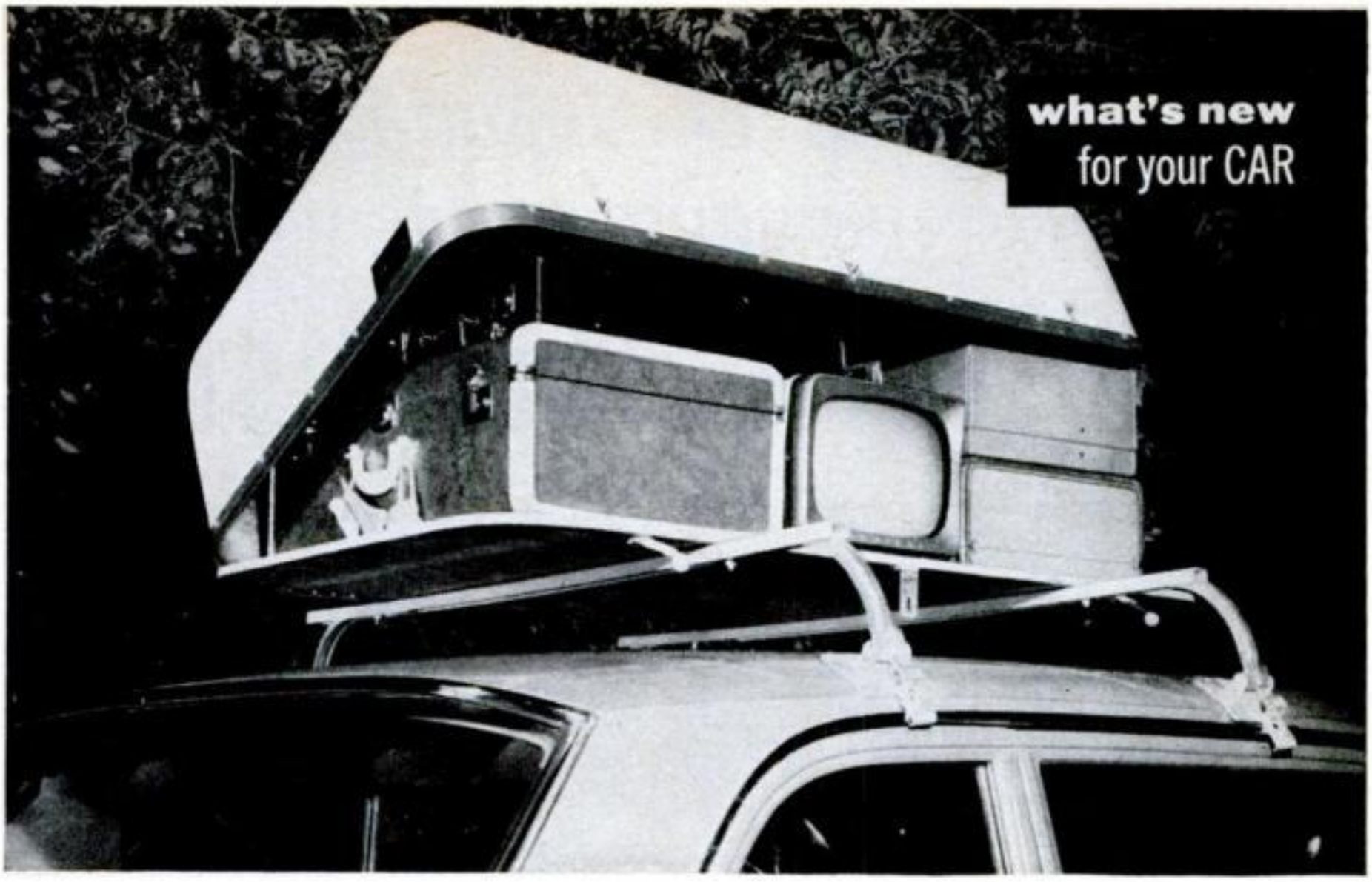
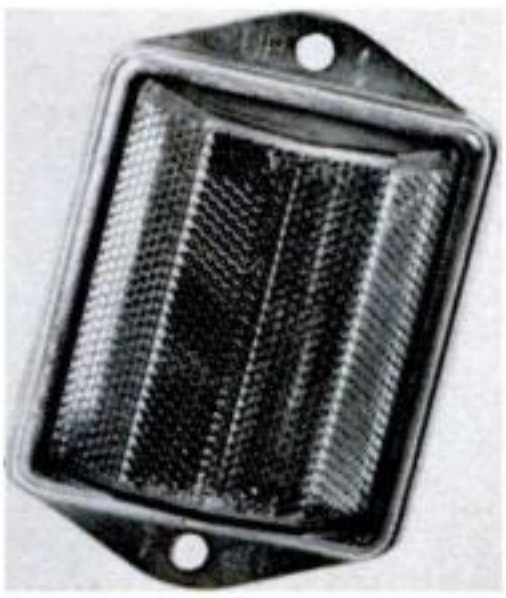


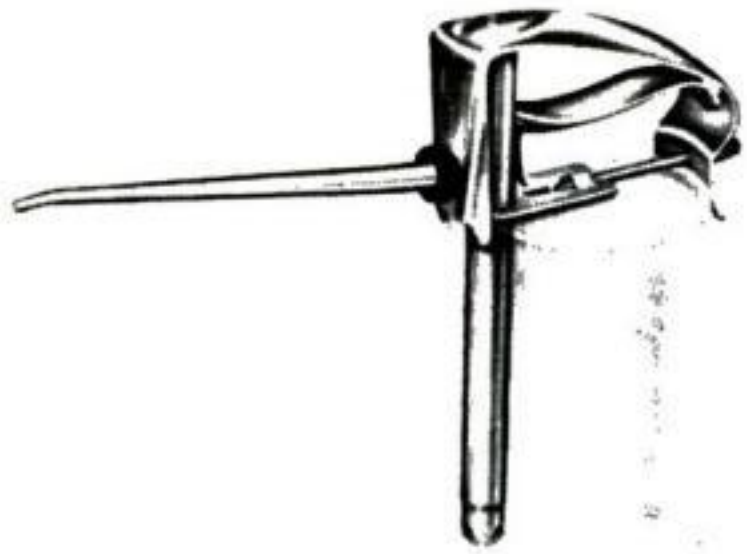
Fiberglass Car-Top Carrier Is Weatherproof

AN EXTRA trunk, this carrier can go on a standard luggage rack or on a special mount supplied by the maker. Its molded fiberglass construction assures permanent color, easy cleaning, and freedom from corrosion. Contemporary Products, Milwaukee, Wis., has developed a series of three sizes—8, 12, and 20 cubic feet—to fit practically every car, station wagon, or convertible in the world. Padlock hasps for locking are optional. Prices start at $49.95; model shown above is $69.95.



New multi-angle reflector lens increases visibility

Ordinary reflectors work only within narrow angles. A new 90-cent Multi-flector gives 120 degrees of reflectivity. Made by AMT Corp., Troy, Mich., it comes in three colors: red, clear, amber.



Pump oiler uses quart can as its reservoir

Press down on the handle of this pump oiler, and teeth pierce the lid of a quart can. Squeeze the lever, and oil comes out in drops or a stream. It's $3.95. Superior Mfg. Co., N. Branch, Minn.

Valve-spring compressor is a time-saver

This tool fits on the rocker-arm stud and makes removal or installation of valve springs a faster and easier operation. Made by the Lyell Engineering Co., Hannibal, Mo., it sells for $15.95.

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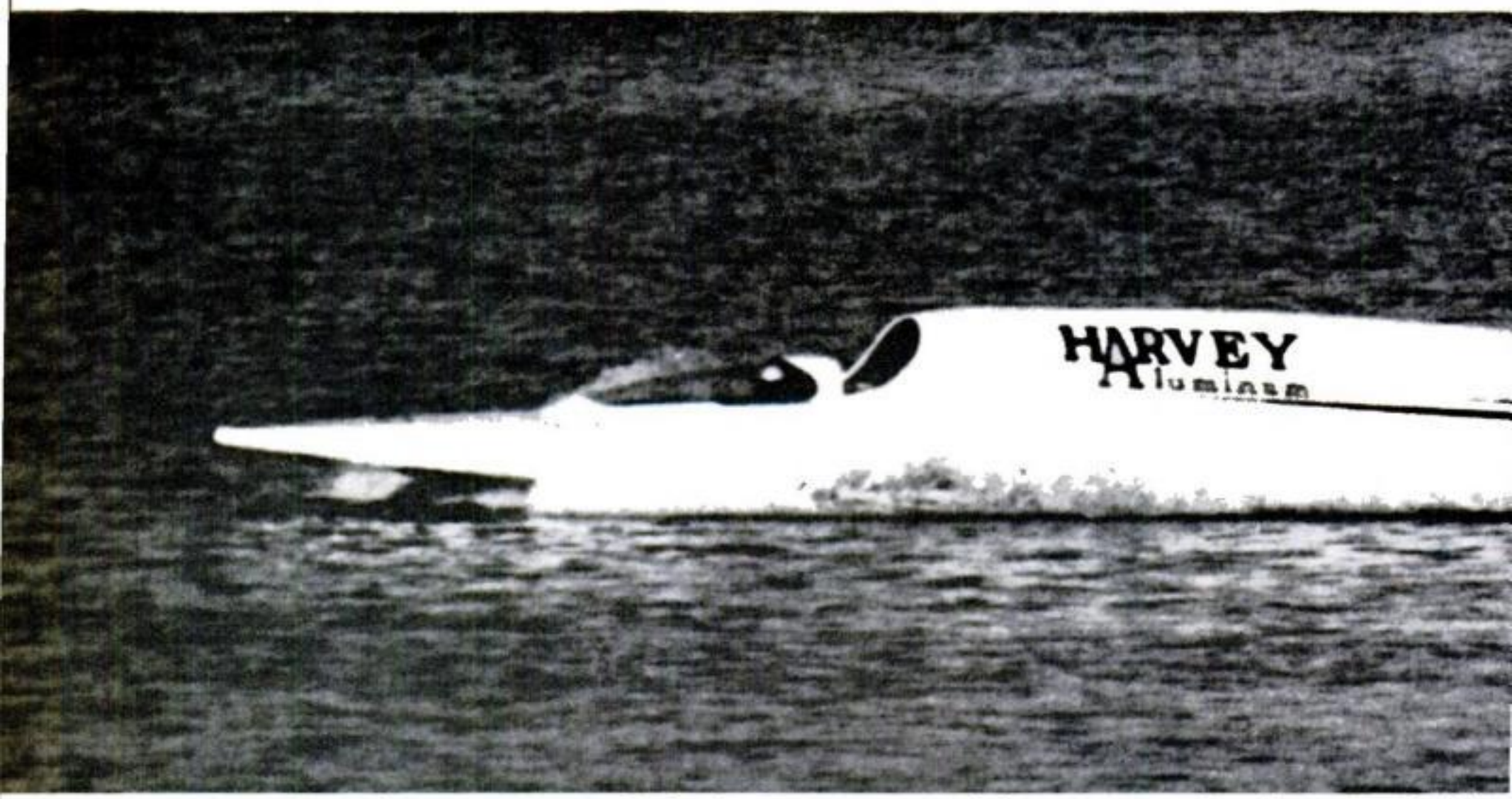
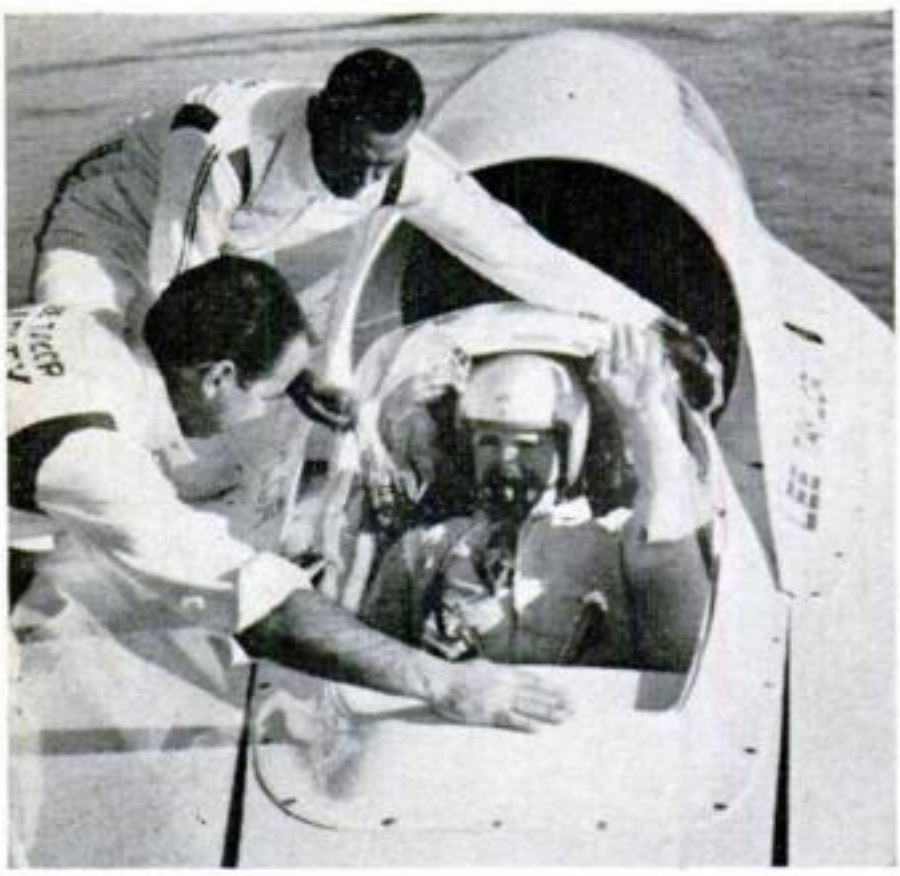
PS EXCLUSIVE

I'm shooting for five miles a minute to become—

The World's Fastest Man



Jet-powered Hustler zooms across Lake Havasu at a speed later estimated to have reached



Leather-padded cockpit of Hustler just takes Taylor's 200-pound, six-foot frame. For the record run, his helmet will be fitted with two-way radio so he can keep in touch with his crew.

After a bad smashup, Taylor and his jet boat are set for an assault on the speed record. His goal: 300 m.p.h.

As POPULAR SCIENCE *goes to press, Lee Taylor and his Hustler are about to take a shot at the world speed record on water, 276.33 m.p.h. Here, in an exclusive article, Taylor reveals how he has licked the almost disastrous problems that beset his trial run over a year ago.*

WE WERE planning to open Hustler up to about 125 m.p.h. on that unlucky Tuesday morning in April, 1964, when I nearly got myself killed. Hustler, my jet-powered

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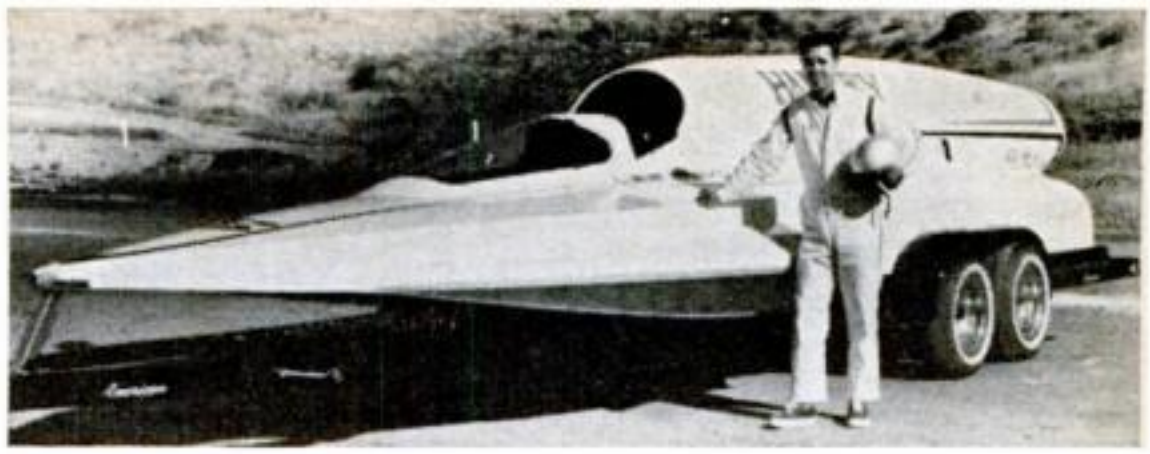
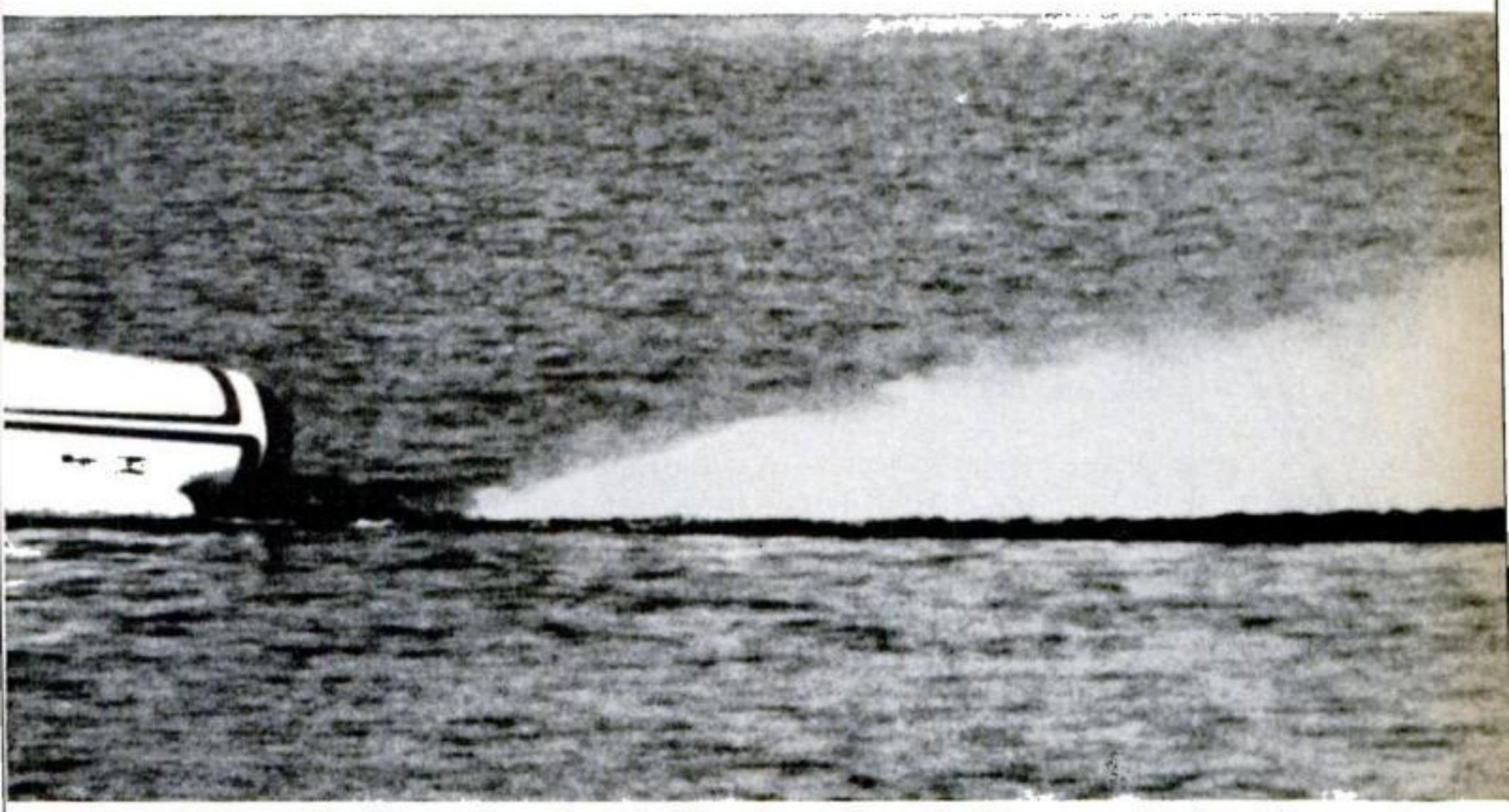
Taylor and jet-engined Hustler with which he plans to capture the water speed record. Aerodynamically shaped aluminum craft has an estimated capability well in excess of 300 m.p.h.



on Water

By Lee Taylor



almost 300 m.p.h. This unplanned trial of boat's speed resulted in a near-fatal accident.

hydroplane with which I hope to capture the world's speed record on water, went like a bomb—much too fast for the four miles of water we had under us at Lake Havasu on the Colorado River in Arizona.

An Army helicopter pilot trying to keep up at a speed of 140 knots said I left him behind as if he'd been standing still—until we ran out of lake. After grazing a narrow point of land and tossing me out on my head, Hustler slid up the shore at the end of the lake and came to rest in gravel and bushes.

I got the worst of the accident, though. My skull was fractured in five places, my right shoulder broken, the muscles of my left eye cut, and my left ankle crushed. I was in a coma for 18 days and in various hospitals for 3½ months.

Even now I am unable to remember just what happened. All we know is based on the testimony of witnesses and evidence found in the boat. We think we have solved the problems. We're ready to try again—probably on Lake Mead, on the border between Nevada and Arizona, where there's lots of room.

Evolution of a boat. Hustler is the fourth boat I've owned with that name in my 30 years. I've always been interested in speed, and the present jet-powered Hustler certainly fills the bill. When I started thinking seriously about trying for the world's speed record 2½ years ago, it was obvious that it would have to be with a jet engine.

Conversations with owners of jet-powered drag racers sold me on the

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Westinghouse J-46 turbojet with afterburner. It whips up 6,200 pounds of thrust at 10,150 r.p.m.—the equivalent of 10,000 hp. The big problem was trying to find one.

I finally got a J-46 from a Navy fighter through a Los Angeles surplus dealer. It was harder to locate an afterburner, but after $200 worth of phone calls I tracked one down in Tucson, Ariz. Engine (1,650 pounds), afterburner (300 pounds), and starter total about a ton, and stretch 17 feet, six inches.

The next move was to design a hull to go with the J-46 power plant. I made a drawing of the engine on a scale of one inch to the foot, and penciled in a typical Rich Hallett hull around it (Rich, the celebrated ski- and drag-boat designer, is a neighbor and friend of mine, incidentally). The tunnel between the sponsons was planned to provide maximum life from trapped air at the point where the engine starts. That's just the way it worked out.

When Gil Peers of Stewart-Davis Co., Long Beach, Calif., representatives for Westinghouse jet engines, heard about the Hustler plans, he mentioned a revolutionary method of steering. Instead of conventional rudder-and-elevator steering, Hustler would use titanium thrust deflectors in the mouth of the tailpipe. At the time, the idea seemed wild to me, but we kept it in mind.

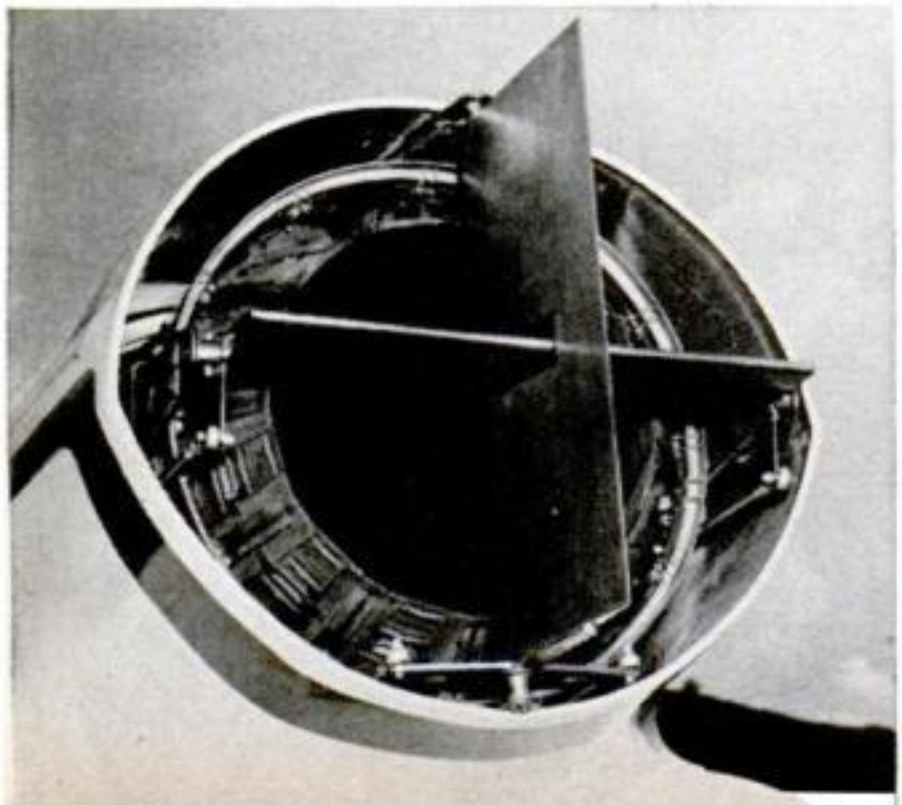
My old friend Larry Lee, a commercial designer and artist, made finished drawings of the new boat from my roughs, making the canopy and cowling much more streamlined. The drawings were placed in Rich Hallett's hands, and he was asked to build a hull to accommodate our ideas. He, too, was in favor of trying thrust-deflector steering.

We decided we'd need aluminum on Hustler. However, the kind of aluminum to be used was very important. In discussing the kinds and amounts of metal I'd need with Harvey Aluminum research-and-development engineers, they became quite enthusiastic about the project. Harvey Aluminum decided to furnish me with the metals I needed—partly for testing purposes—and eventually became my major sponsor.

Converting the engine. Hustler owes a good part of its existence to Harvey's metallurgists and engineers and two jet mechanics from Stewart-Davis: Marvin McAfee and Jim Maxwell. Marv, Jim, and I worked every night for months, often till early-morning hours, adapting the J-46 airplane engine to a boat hull. It was a terrific job. The engine is extremely complicated, and was intended to be fully automatic. We removed the automatic feature along with more than

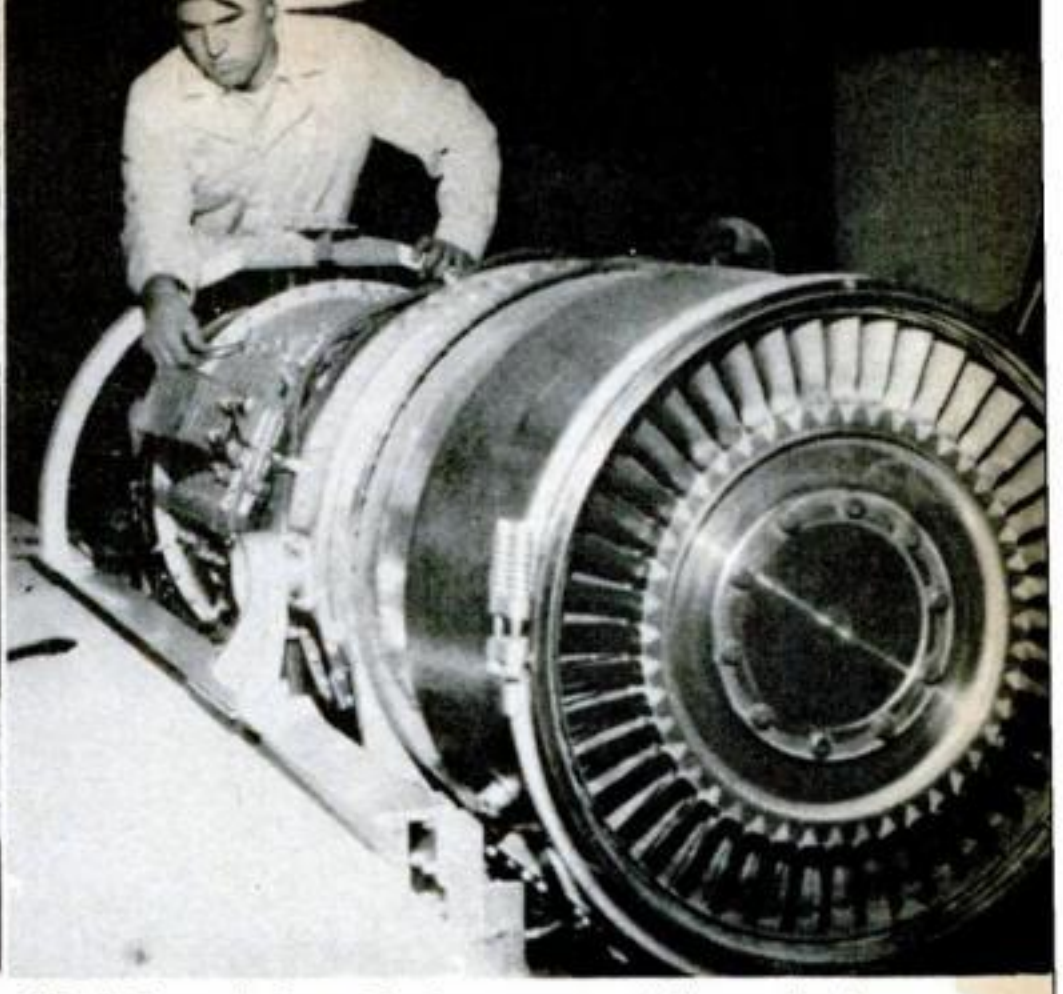
This was the scene on April 14, 1964, after Hustler skimmed across a point of land and came to rest in bushes and gravel on shore. To quote Taylor, "She just ran out of lake."

Novel rudder-elevator thrust deflector works efficiently as long as power is applied. It has been supplemented by a water rudder and fin, which give Taylor control with a dead engine.



Urheberrechtlich geschütztes Material

Damage to craft was relatively minor—left sponson was sheared off and a small hole staved in hull—and she was afloat in four hours after crude patchwork. Taylor wasn't so lucky.



Undefeated, Lee Taylor returned from the hospital, went to work overhauling J-46. All 900 blades of the jet engine's compressor had gobbled dirt, had to be hand-sanded and cleaned up.

half of the original instrumentation.

When automatic, the J-46 usually runs at a constant 10,150 r.p.m. We adjusted it to manual operation so we can set the aperture of the afterburner where we want it before a run. As a result, engine r.p.m. is no longer constant and varies directly with the power setting. With the throttle set at about 80 percent r.p.m. I expect Hustler to set a new record—300 m.p.h. or better.

Fueled, Hustler weighs 4,800 pounds. Her beam is eight feet, her draft only six inches. The boat is three feet, 10 inches high, and 30½ feet long.

Aluminum extrusions were used to tie into the Hustler's strong oak framework, and the boat bottom is sheathed with .090-inch-thick aluminum. Because of the extreme heat generated by the jet engine, titanium was used for mounting the afterburner and for the thrust deflectors—the elevator and rudder.

Ironing out the bugs. In her first trials, Hustler sat in the water beautifully, and came right up and started planing at about 45 m.p.h., with a nice, clean approach. When I got the boat up to 100 m.p.h., however, she began to wander. We needed a bigger rudder and a water fin for better control.

Before we added the water fin, the bottom had been perfectly flat from the transom to a point beneath the engine intake. From there it rises eight inches to the tip of the sharp prow. We designed the boat so that its deck pressure would be greater than bow lift. This gives it negative dihedral, which works against the planing effect and tends to keep the nose of the boat from lifting too high. We reinforced this effect with the elevator, which we set before the run at an angle that would give the hull its best line of attack. Add to this the gyroscopic effect of a jet engine, which tends to keep the boat moving in a straight line, and we felt we had everything needed to keep Hustler from becoming a flying machine.

When I found that steering control was lacking at 100 m.p.h., we increased the width of the rudder deflector blade from 5½ to 12 inches and shortened its length to 23 inches. We left the elevator deflector blade as it was: 5½ by 24 inches. An aluminum water fin three feet long, 10 inches deep, and widening rearward from ⅛ inch thick to ¾ inch, was fastened to the boat's bottom with its trailing edge flush with the transom.

[*Continued on page 180*]

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PS ELECTRONICS

PERSONAL-USE REPORT:

Big-Screen Color TV Comes in a Small Package

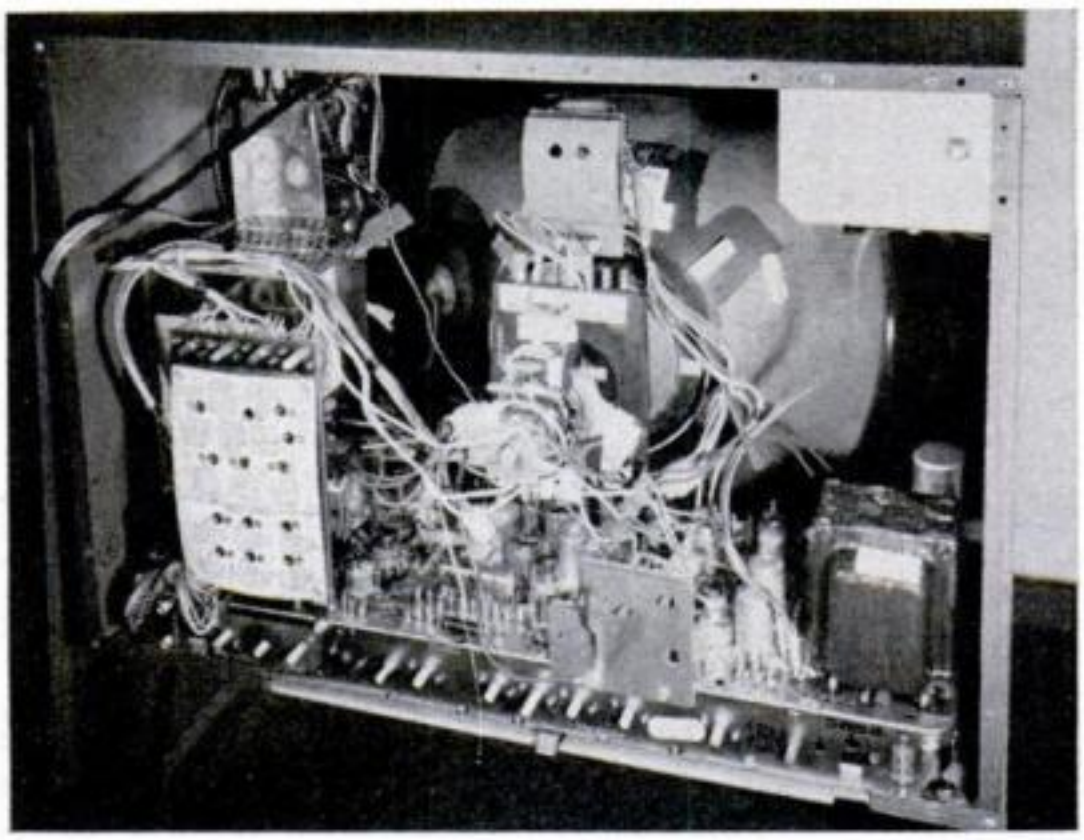
Color purifier, built-in and pushbutton controlled, needed help when set was installed: An external handheld degaussing coil (above) was used to demagnetize the set's steel cabinet. This adjustment was a one-time-only job.

FROM the front, the Motorola Compact color set seems to be all picture: Its jumbo 23-inch rectangular screen is set in a cabinet that measures a scant 27 inches wide and 19 inches high. And it's only 21 inches deep. That's a good six inches smaller in all directions than most 21-inch color sets.

What makes it so compact? Two recent engineering developments:

- A short-neck picture tube that fits easily into the shallow cabinet.
- A simplified color circuit that fits on a smaller chassis.

Color picture quality? To my eye, it's excellent across the entire screen. There's no "pincushion" distortion (distortion in the square corners and at the screen edges) that plagued earlier rectangular-face sets.



Serviceman's view of chassis type TS-914 is shown above. Chassis is used in every Compact color set. Open layout should make servicing simple. Depending on the cabinet style you choose, prices range from $470 to $550.

Colors are bright and vivid, but don't seem gaudy and unnatural. The tint control makes it easy to adjust color balance for perfect flesh tones (usually the hardest shades to reproduce faithfully).

Black-and-white picture quality surprised me: No fuzziness, yet you can't see the scanning lines. I prefer black-and-white viewing on this set to viewing on my 21-inch black-and-white set.—*R. Benrey.*

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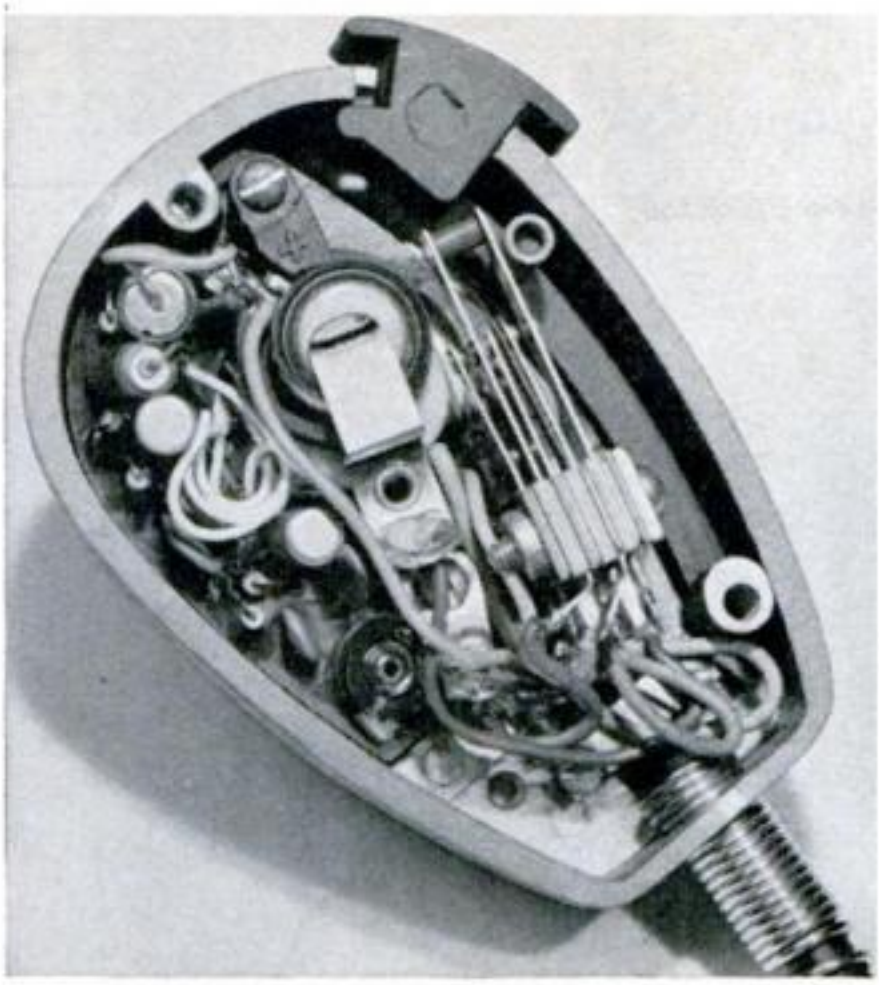

CB Mike Has Built-In Voice Clipper

THE transistorized voice-clipper circuit built into this handheld mike (above) can double the effective range of your Citizens Band radio transceiver.

Your voice contains both loud vowel sounds and softer consonant sounds—but it's the latter that contribute most to speech intelligibility. The voice clipper cuts off the peaks of the loud sounds, enabling the softer sounds to modulate more of the transmitted signal. This makes weak signals easier to understand at a distant receiver.

The two-transistor circuit is powered by a long-life mercury battery. Cost with push-to-talk switch and coiled cord: about $25. Electro-Voice, Inc., Buchanan, Mich.

First report: GE's 11-inch-screen portable color TV

Now there's a color TV you can lift with one hand: The new General Electric portable color set weighs only 24 pounds.

Heart of the set is its 11-inch color picture tube—a scaled-down version of the conventional three-electron-gun color tube used in big-screen sets. GE reports the baby tube is simpler and more rugged than its big brothers, and that the set can be moved without disturbing the critical beam-convergence adjustments.

It will be available late this fall. Cost, with built-in degausser (color purifier) and dipole antenna: $250.

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PS Builds

A picture! All it took was one last twist of the "azimuth" knob.

At last! A workable home TV tape-recorder kit that shatters the

By Ronald M. Benrey

IT SOUNDED incredible. A TV tape recorder you build from a kit for about $400? That's exactly what the note from our European Editor said. A small British electronics firm—Wesgrove Ltd.—was offering the kit for sale to experimenters and electronics hobbyists.

Its specifications were brief: The VTR-500 records and plays back black-and-white television when connected to any standard TV set.

But I was still staggered by that $400 price tag. The cheapest factory-built TV recorders cost several thousand dollars. I know; I've gone shopping. Ever since PS reported the first prototype TV recorder for home use [Oct. '63], I've dreamed about owning my own personal machine.

What would I do with it? In the beginning, I'd record the best TV shows so I could play them back whenever I wanted. I might even collect a tape library of televised plays, concerts, movies, operas, championship athletic events.

But that's not all. Why couldn't my wife record the Saturday-afternoon ball game? Then I'd be able to watch it in the evening when I came back from the golf course. Someday, I might even add a low-cost closed-circuit TV camera, and make TV "home movies."

True, $400 buys a lot of lunches, but the VTR-500 was too good to pass up. I figured I could swing it without selling the family buggy.

Our kit had to be shipped to us from England, but if you want a VTR-500, you can order it from the new U.S. distributor: P.A.F. Enterprises, 32 E St., Bayonne, N.J. The price is $405 FOB Bayonne.

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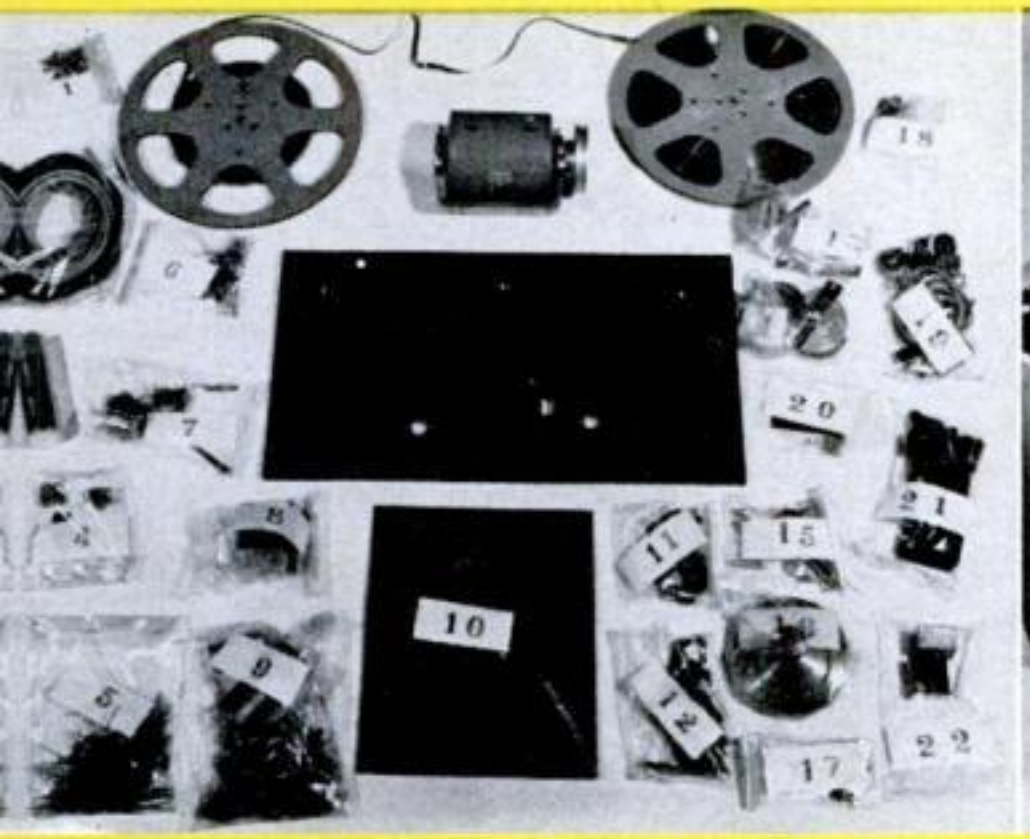
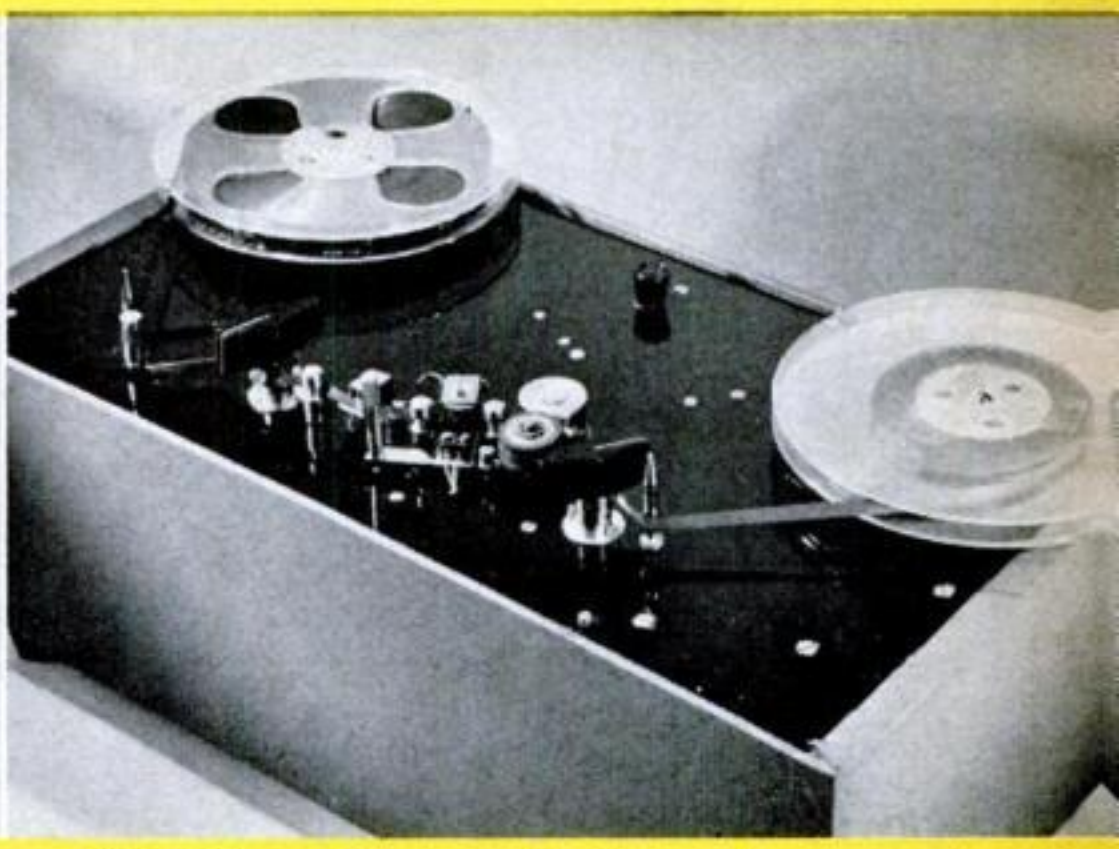
a TV Tape Recorder

...and so can you



Here's what the mailman brought. The parts were packed in numbered plastic bags keyed to the instruction manual. The kits are now marketed with the tape deck preassembled.



VTR-500 ready to roll: Note the tortuous threading path the tape follows past the heads. This photo shows seven-inch reels on machine; don't use them! Reason? See bottom of next page.

$500 price barrier. Any electronics buff can build it. Cost: $405

The chances are that any advanced electronics buff with a lot of patience can assemble the VTR-500. It is definitely not a kit for beginners. It took me 30 hours to bolt and solder things together, 20 more to hook it to my TV set, and a final 100 hours to get the controls adjusted.

150 hours later. When it's finished, the VTR-500 looks as if it's built from surplus sewing-machine parts. It makes noises like

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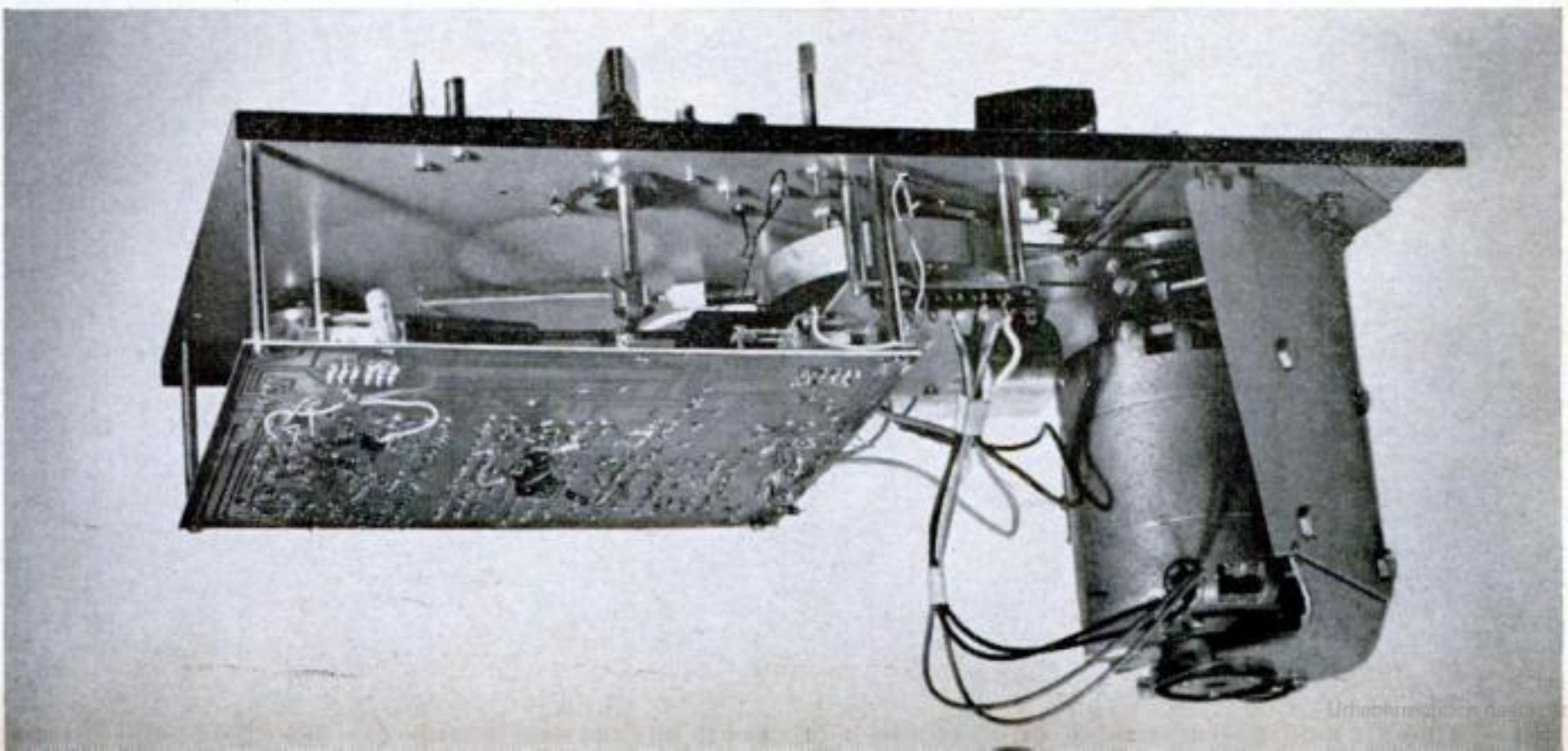
Large printed circuit board holds a 23-transistor record-and-playback amplifier. The heavy flywheel (to left of motor) stabilizes tape speed. The motor's rated at 1/10 hp.



a runaway lawn mower, occasionally chews up a reel of tape, and may catapult a half-full reel across the room.

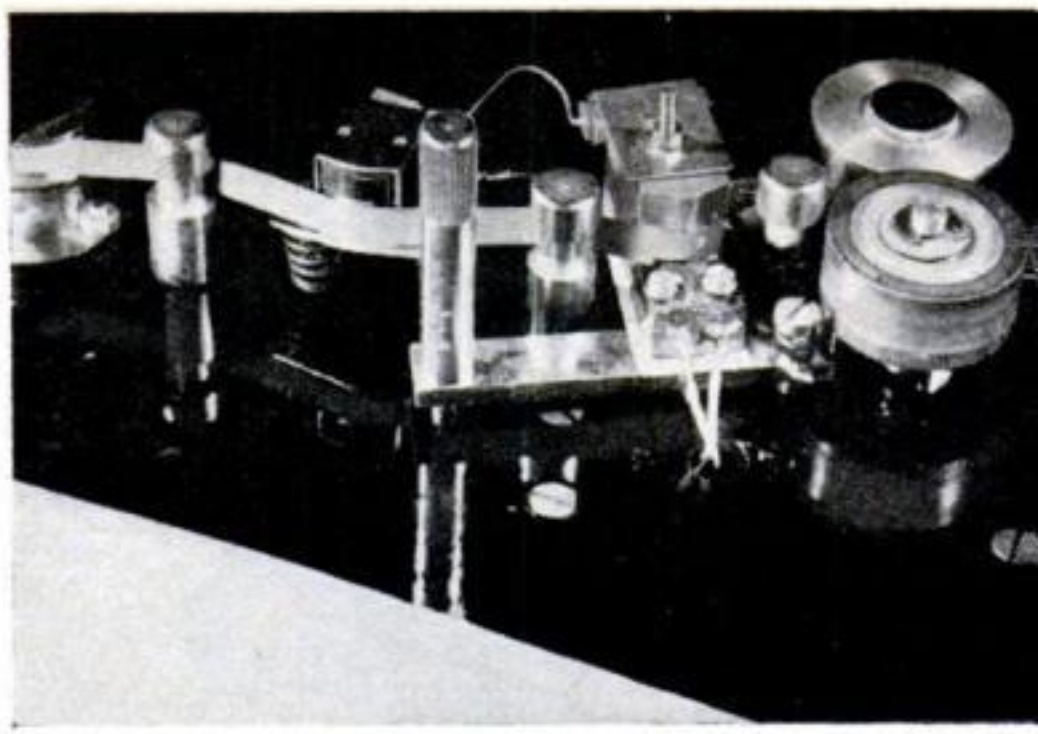
In spite of its shortcomings, the VTR-500 *does* record and play back television through my TV set. It doesn't have a single frill or luxury—not even a tape rewind—just the minimum equipment needed to do its job.

How it works. The VTR-500 in action looks a lot like a conventional audio tape recorder. A motor-driven capstan propels ordinary ¼-inch-wide audio tape from a supply reel to a takeup reel, across a recording/playback head assembly. That's where the similarity ends. The VTR-500 has two record/playback heads: one for video and one for audio.

Video signals are recorded on a narrow track along the bottom edge of the tape, audio signals on another track just above. Both tracks take up less than half the tape width. After one recording pass, the tape can be "turned" over, like a hi-fi recorder tape, and run past the heads again to record on its clear edge.

To make a recording, audio and video signals from your TV set are fed to the VTR-500's recording amplifier. The audio signal is taken from across the set's loudspeaker; the video signal, from the set's video circuitry. The recording amplifier "distorts" these signals in a precise way, transforming them into signals that can be recorded easily on magnetic tape.

The recorder's playback electronics undo the damage: They take the signals from the tape and restore them to a form the TV set can use to produce sound and picture. The audio signal is fed to the set's audio amplifier; the video signal to the input of its video circuitry.

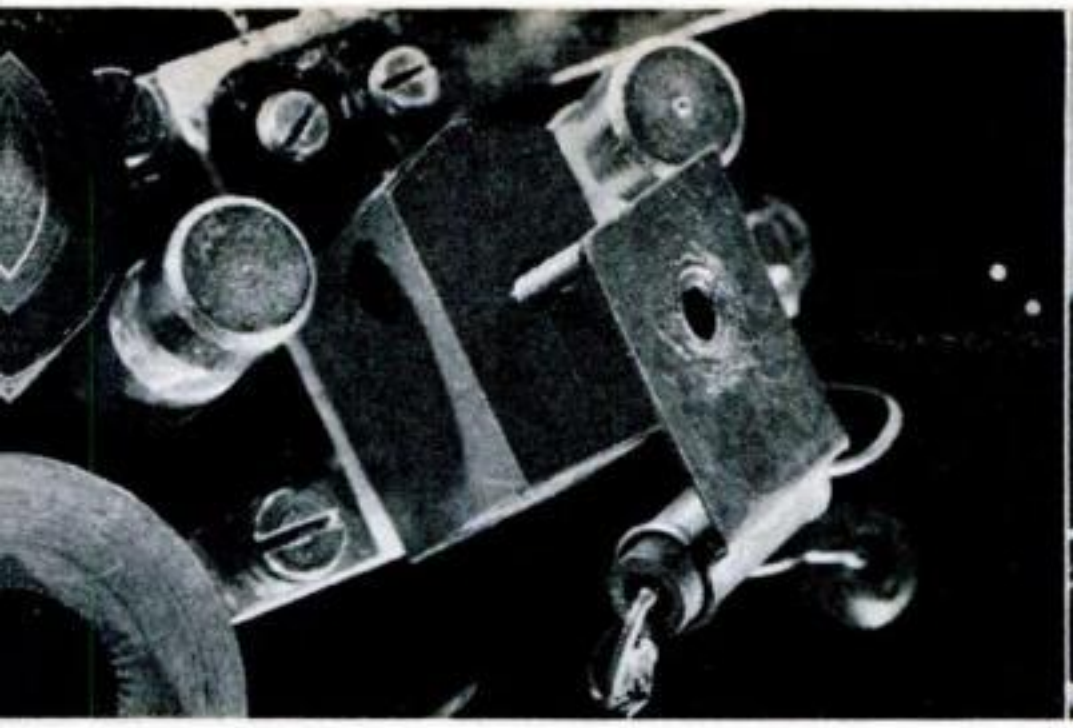


Critical adjustment—head azimuth—is made by turning the knurled-top shaft (left of center). It controls the slant of the video head with respect to the path the tape follows.

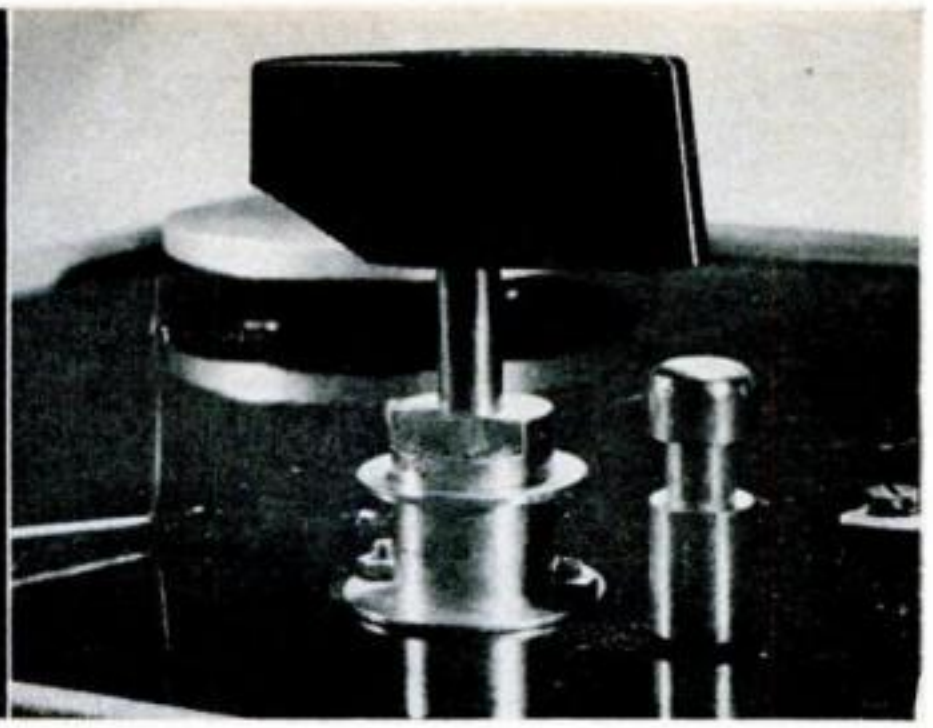
Video signals are wary beasts. They're difficult to capture on tape—that's why TV tape recorders are so expensive. A video signal is a complex blend of high- and low-frequency components that spans a frequency band almost three megacycles wide. Unless the recorder catches most of this band width, picture definition and contrast will deteriorate during playback.

The VTR-500 uses a brute-force method to achieve a wide video-recording band—a very high tape speed. Tape moves at an

Trouble: This happened if: 1) the tape accidentally broke, 2) seven-inch reels were used, 3) the takeup-reel drive clutch slipped, and 4) any of the shaft-locking setscrews loosened.



"Head heater" helps cut down video-head wear. Tape glides smoothly across the heated metal head—its abrasive iron-oxide coating flowing, rather than dragging across the gap.



"Bias" magnet is mounted on control shaft. Tape rides over it, and is partially magnetized prior to recording. In first tests, its edges were too rough; it scraped oxide off the tape.

awe-inspiring 180 inches per second (24 times the speed of hi-fi audio tape).

At full gallop, the VTR-500 has a just-adequate video-recording band width of a little more than two megacycles: The picture is less than perfect—it's fuzzy and a bit jittery on occasion—but it's perfectly watchable.

There's a catch: 180 i.p.s. gobbles up tape at over 10 miles (or about $50 worth) an hour. An oversize 11¼-inch reel of triple-play half-mil mylar tape lasts about 10 minutes. Run through in both directions, a jumbo reel records only 20 minutes of TV.

Tricky work. Moving tape at 180 i.p.s. takes a lot of power. The VTR-500's tape transport uses a 1/10-hp. motor to spin the tape-drive capstan (audio recorders get along with a fifth the pulling power).

Speed stability is a problem. Unless the tape is pulled past the head at a constant speed, the playback video signals won't synchronize the TV set's picture—it will "roll" and "tear" just as if the set's vertical- and horizontal-hold controls were set incorrectly. What causes speed instability? The worst culprits are dust and dirt on rotating bearing surfaces, uneven tape thickness, and power-line voltage fluctuations.

A heavy, balanced flywheel on the capstan shaft works at keeping the tape speed relatively uniform, and the transport's stiff steel baseplate fights—but rarely eliminates—tape-twisting vibrations that cause additional instability. Unfortunately, as the instruction manual points out, the VTR-500's simple mechanical system just isn't capable of maintaining sufficiently constant tape speed. The recommended solution is a simple circuit addition to your TV that enables it to lock in on the wavering video signals.

Next to watching playback of a TV show, the most amazing sight from the VTR-500 is the horrendous tangle that develops if the tape goes haywire. If the tape breaks or slips out of its guides, usually 200 or so feet of tape wind up on the capstan before you can cut the power. The only way to get the tape off the capstan is with a razor blade.

The heat treatment. Even at low audio-recorder speeds, the tape's iron-oxide coating acts as an abrasive; at 180 i.p.s., wear of the critically proportioned video head becomes a formidable problem. The recorder has a unique solution: Whenever the tape is moving, the head is heated by an energized one-watt power resistor strapped to it with a copper bracket (the head gets warm to the touch).

The tape's oxide coating tends to flow smoothly across the heated head, rather than rub across it. As a result, the video head has a rated life of about 200 hours. A replacement costs under $10. Audio-quality triple-play tape holds up for about 100 runs; lubricated "instrumentation" tape lasts considerably longer.

Is it hard to build? Putting the VTR-500 together was a relatively straightforward job: Mechanical assembly was simple and the electronic components plugged into an easy-to-wire printed circuit board. If you build one, you'll have even less work to do: New kits have a preassembled tape transport.

The most time-consuming tasks are finding the correct settings for two critical

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Don't want to pioneer? For the less-adventurous TV taper, there's a prebuilt, pretested version of VTR-500, the VTR-600. It's more refined, has added controls, costs $550.

controls: video-head "recording-bias" current level, and video-head "azimuth." The only way to find the ideal points is by trial and error—and it can take weeks of spare-time fiddling.

Recording bias is the DC fed through the video head when it's recording a signal on the tape. Its level is set by a small rheostat. Azimuth is the relative incline of the video head to the path of the moving tape.

Should *you* build one? If you have an uncontrolable urge, as I did, to own the first TV tape recorder on your block—and you have a solid knowledge of TV electronics—go ahead. Otherwise, consider buying the VTR-600, a factory-built version of the 500. It will cost you $550.

In all fairness: Our kit was a very early model and was loaded with bugs. Most have been eliminated in newer recorders.

Instructions? The manual I got was the worst I've found in an electronic kit. The newly revised one is better, but still nowhere near as comprehensive as manuals of major U.S. kit makers. Forget the VTR-500 kit if you count on step-by-step, "solder-don't-solder" instructions.

Test equipment? The bare minimum is a multirange volt-ohm-ammeter for adjusting the critical control settings.

My conclusion is that although the VTR-500 has more rough edges than a sack of uncut diamonds, I got my money's worth when I bought it. To me, it's an electronic Model T—a working, bargain-basement TV tape recorder that's crudely designed and temperamental to operate. I hope you have as much fun building it as I did. ■ ■

Sony Videocorder tapes TV at slow speed

This new home-TV tape recorder has a rotating video head—like that on professional studio machines. The Videocorder uses a special ½-inch-wide tape looped in a half-spiral around a slotted drum containing a spinning video head. As tape is drawn around the drum (at a slow 7½ i.p.s.), the head records the video signal on narrow adjacent bands on the tape. With built-in TV set: $995. Sony, 580 Fifth Ave., NYC.

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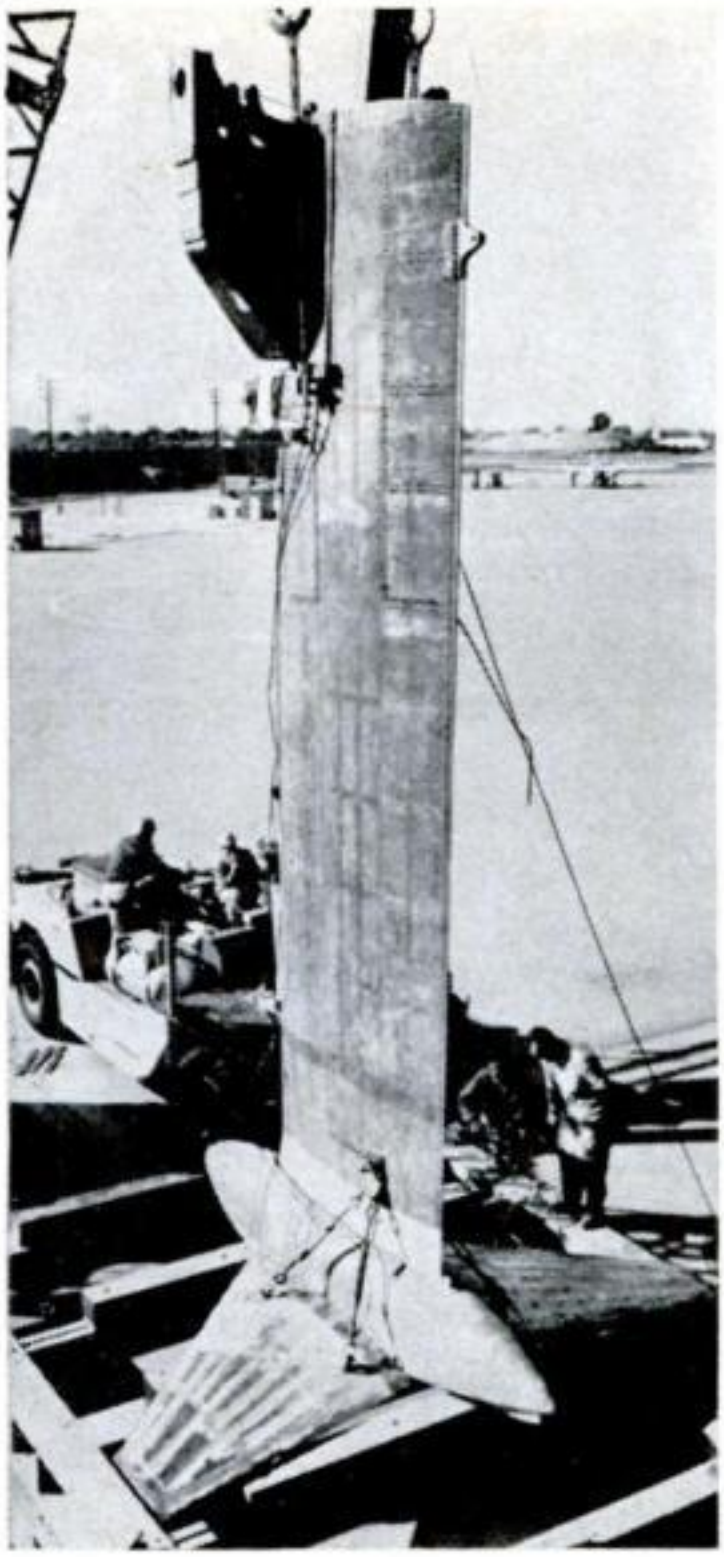
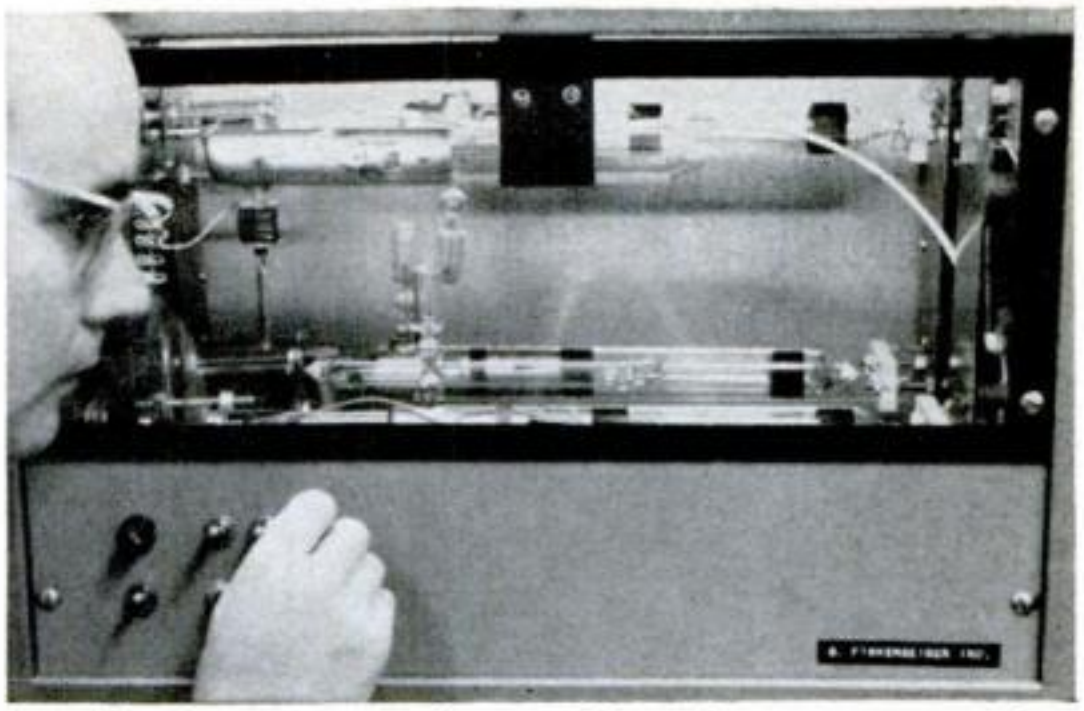


Sea legs for "flying" ship

This giant hydrofoil assembly is one of three that will enable the Navy's 300-ton Plainview to rise out of the water and "fly" at cruise speeds of 60 m.p.h. The 220-foot-long experimental vessel will be the world's largest. Its winglike foils at sides and stern are 25 feet tall, weigh seven tons each, and have a span of 13½ feet.

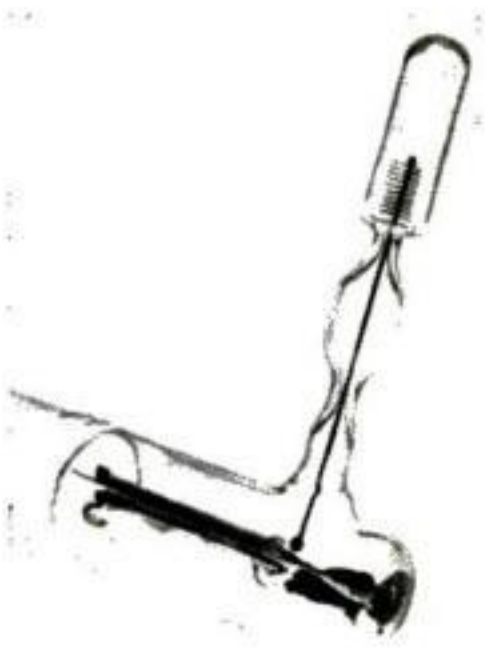


Switches start motors that revolve tubes containing glass bells. Pushbuttons control connections to amplifier.

Church chimes need no bell tower

Parishioners in Dedham, Mass., had a pleasant surprise early this year when they heard what they thought were massive bronze bells pealing from the Church of St. Susanna. The church had been built three years before without a bell tower. Actually, what they heard was the result of electronic and glass-blowing magic. The source of the chimes was a two-foot-long metal cabinet containing four glass bells with tiny striking hammers and an electronic amplifier that boosted the sound 100,000 times.

First in this country, the chimes were built by a German immigrant, Gerhard Finkenbeiner, maker of glass scientific instruments for Brandeis University and now living in Bedford. He has put the system in 10 European churches, is installing it in two more.



Close-up of tube shows gold-coated vibrating components. Spring lets glass-tipped hammer strike once, then holds it.

Outdoor medicine cabinet

A medicine cabinet you can hang on a tree has a shelf with built-in stainless-steel shaving mirror and drawers for toothbrushes, combs, shaving articles, cosmetics, soap, and first-aid needs for a family camping trip.

Made by Vesely Co., Lapeer, Mich., trailer manufacturers, Medi-Kit sells for $18.75.

Urheberrechtlich geschütztes Material

Look what's

Revolutionary changes in the familiar two-wheeler are making the bicycle more popular and more practical than ever

By Albert Wall

THE bicycle, long man's most ingenious, efficient, and economical means of transportation, is getting a brand-new, even exciting, look. Bike design, stodgy and unimaginative for 70 years following the invention of the basic "safety" bicycle, is making up for lost time with a vengeance:

- You can now get a lightweight 10-speed club model similar to a racing bike—but at a fraction of the cost.
- For small and middle fry there's the "high-riser"—those sporty, fast-accelerating jobs with the small wheels, high handlebars, and banana seats.
- Scads of accessories and gadgets are around. Take your choice of automatic shifts with shoe brakes, twist-grip gearshift controls, "derailleur" mechanism, toe clips, thornproof and racing slick tires.
- Most radical of all is the new Moulton bicycle (below and at right). Based on new concepts, it's fast, maneuverable, absorbs road shock, and has great package-carrying capacity.

Club cycles. Although the great cycling nations—England, France, and Italy—developed lightweight multispeed bikes some years ago for racing and touring, it was not until this decade that Americans discovered the joys of effortless lightweight cycling.

The big breakthrough for the club cyclist is the new derailleur mechanism—an artfully contrived gear device that derails the spring-loaded chain, picks it up, and moves it over as many as five rear sprockets and two larger front sprockets. This results in 10 speeds of an equal number of gear ratios, depending on the number of teeth on each sprocket. In addition to being more ver-

CONTINUED

Bicycles from 1895 to 1965

For a graphic view of the revolution in bicycles, compare the "safety" bike in the early photo at top of the page with that at the right, held by its inventor, Alex Moulton. The Moulton, a maneuverable, fast-accelerating machine, uses small 16-inch wheels with high-pressure tires, and has a unique telescopic front suspension and shear-joint rear suspension to iron out any road bumps (see drawing). Small wheels leave generous carrier space at front and rear.

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happening to BICYCLES

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Side-by-side riding on the Twin-Flight Combo—two bikes stabilized by front leaf springs and a joining fixture at rear hubs. Top bar synchronizes steering. It's new from American Machine and Foundry.

Today's bicycles come in

Updated popular middleweight is this Huffy 26-incher with three-speed twist-grip shift.

Conventional lightweight model from Chain Bike Corp. features three speeds, hand brakes.

satile than the three-speed hub used on many gear-shifting bicycles, the derailleur has another advantage: With the three-speed hub you have to stop pedaling or slow down to change gears; with the derailleur you continue to pedal to effect a shift—insuring continuing momentum on hills.

Further refinements of the club cycle are the turned-down handlebars, which enable the rider to use his arm and back muscles while cutting wind resistance, and the rat-trap pedal with toe clip and strap. The strap permits the rider to lift with one leg while the other powers the downstroke; the toe clip automatically and correctly positions the foot with the weight on the ball only.

For Junior: the high-riser. Those bizarre-looking bikes with elevated saddles and exaggeratedly high handlebars are what the trade calls "high-risers." According to the Bicycle Institute of America, with 57 million cyclists in the country purchasing an average of five million bikes a year, times were ripe

How to choose a bike

Two-wheelers come in five main types: 1) children's—heavy, wide tires, high bars; 2) lightweight—three-speed, hand brakes, 30-40 lb.; 3) club—10 speeds, dropped bars, about 28 lb., 4) racing—like club, but about 22 lb.; and 5) specials—tandems, high-risers, Moulton.

Most adults will choose from categories 2 and 3, and will get just about what they pay for. Good domestic and imported lightweight machines can be had for around $55, while club models for touring range from $70 to $225. Not all multispeed models are imported. American Schwinn bicycles can be had in most categories and price ranges. Anything in the $100 area, and above, will usually satisfy all but the very serious cycling enthusiast.

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many shapes and sizes

A "lifetime" bicycle (it can be adjusted for riders of all ages), the new Hi-Lo bike by MTD Products, Cleveland, offers you take-apart portability, small 16-inch wheels, and easy operation.

Murray Wildcat is deluxe high-riser-style bike with three-speed shifting, hand brakes.

Representative of club racing models, this Columbia bike has 10-speed derailleur mechanism.

Unique conversion unit in the Schwinn line makes a two-wheeler into three-wheel golf bike.

Sporty high-riser, Rollfast's Skoot 23 has polo seat, nobby rear tire, high handlebars.

for a style change. The answer was a sporty-looking bicycle that could be dressed up much like a motorcycle, with headers, torsion bars, and foot pegs.

The high-risers are designed with a short wheelbase and small wheels, making them extremely maneuverable, while a low gear ratio yields fast starts.

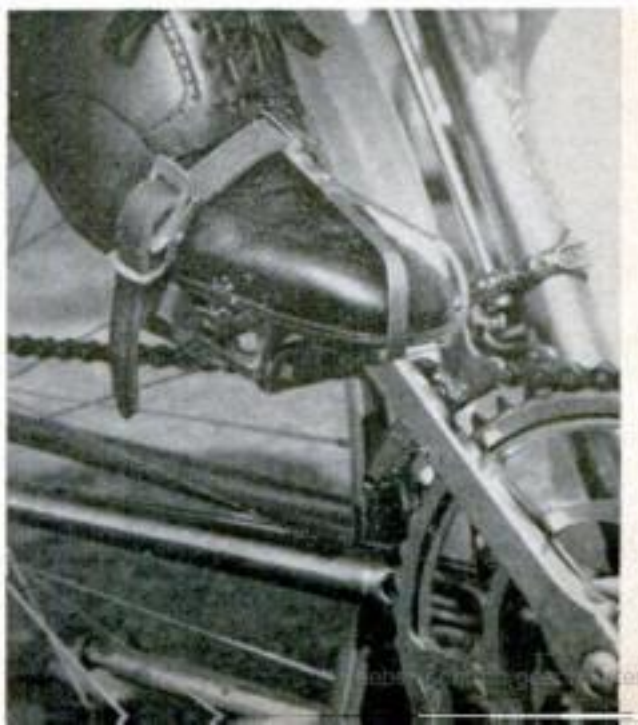
James Hayes, the Institute's director of information, says the high-risers have the same appeal for the younger set as sports cars and motorcycles have for their elders. Are they safe? "Yes," says Hayes, "so long as the handlebars are not too high above the seats." With the BIA predicting a 100-percent increase in sales this year, it looks as if high-risers are here to stay.

The extras. Other new developments on the scene include speed hubs operated by twist-grip controls (some from Japan); the Bendix two-speed automatic hub shift with fail-safe shoe brakes; a folding bike made by MTD Products; a Darwin reflector made especially for

[*Continued on page 145*]

Close-up of derailleur by Schwinn (left) lets you see how its spring loads chain, picks it up, and moves it onto another sprocket when actuated by the shift lever.

Rat-trap pedal (right)—an assist to touring cyclists—makes it possible for rider to lift up with one foot, push down with the other.



You'll make tough cutting jobs easier
and do them faster with—

Notched Jigs for Your Table Saw

By R. J. De Cristoforo

HAVE a piece you can't saw accurately with the miter gauge or rip fence, or a piece too small to be hand-held safely? You may find that a simple notched jig is the answer.

Take a piece of wood and cut out a notch along one edge. The notch may be the shape of the part you want to keep—as in the case of small wedges. Or it can be the shape of the waste piece which will be cut off—as in the case of a taper cut.

Usually, the notched jig will ride along the rip fence, acting both as carrier and gauge. The jig will allow you to position the work precisely, even when unusual shapes are involved.

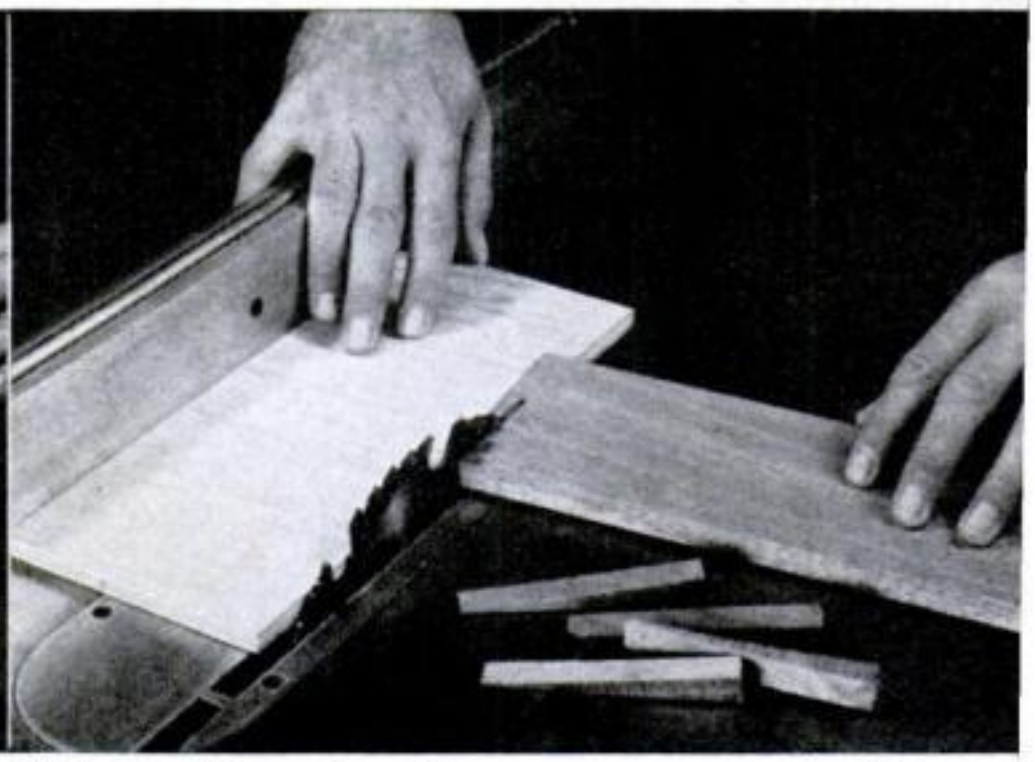
Jigs of this type make sense when:

1. You need a part so small or so oddly shaped it can't be hand-held safely.
2. The cut is such that the piece can't be held in the normal manner with the miter gauge or rip fence.
3. You need many identical parts.
4. A slight error is magnified because the same cut must be repeated on multiple parts which are then assembled. A case in point is a picture frame. A single degree, or even less, multiplied eight times becomes a very obvious gap.

You can, of course, set the miter gauge accurately, position each cut carefully, and hold on tight to prevent creep. But using a notched jig will eliminate these headaches and put you on the road to more accurate cutting.

Of course the jig must be made accurately. This may be too much trouble when you only need a piece or two. At such times, if accuracy is critical, it may be better to lay out the workpiece, cut just outside the line, and then finish the job on a belt or disk sander.

To form tapers, notch the jig to the shape of the waste piece. Feed the work until the waste passes the blade. For an identical taper on the opposite edge, flip stock and repeat cut.



Make small wedges the same way you would form tapers. Cut the base stock so grain direction runs right. Make the cut with the point of the wedge entering the saw blade first.

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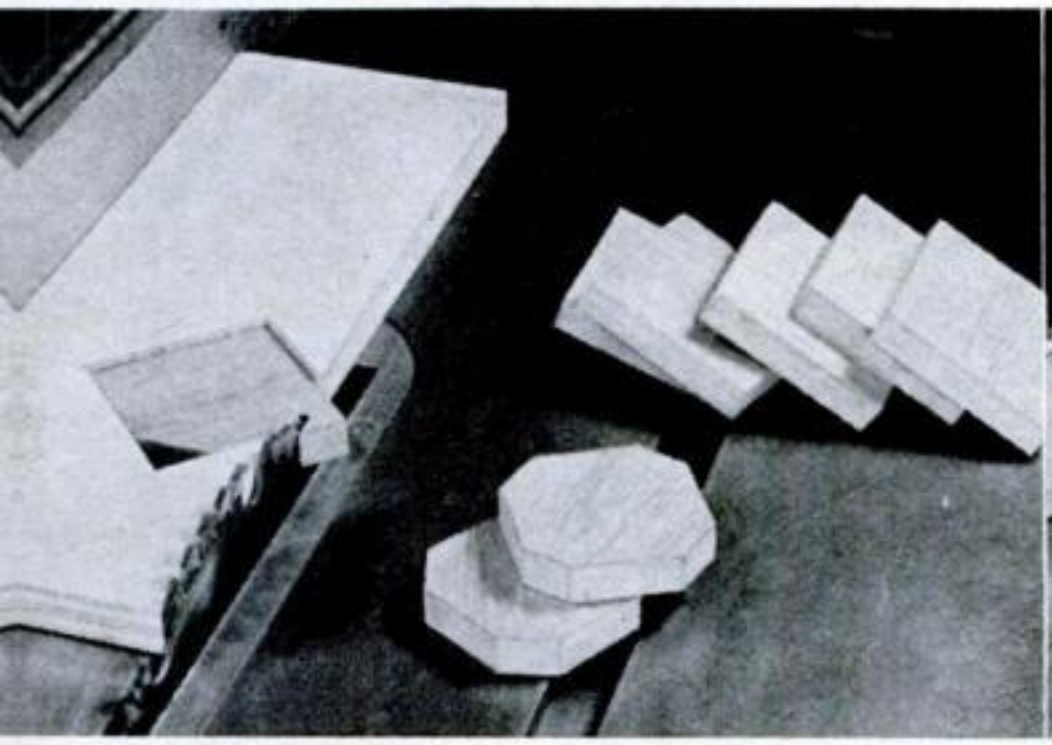
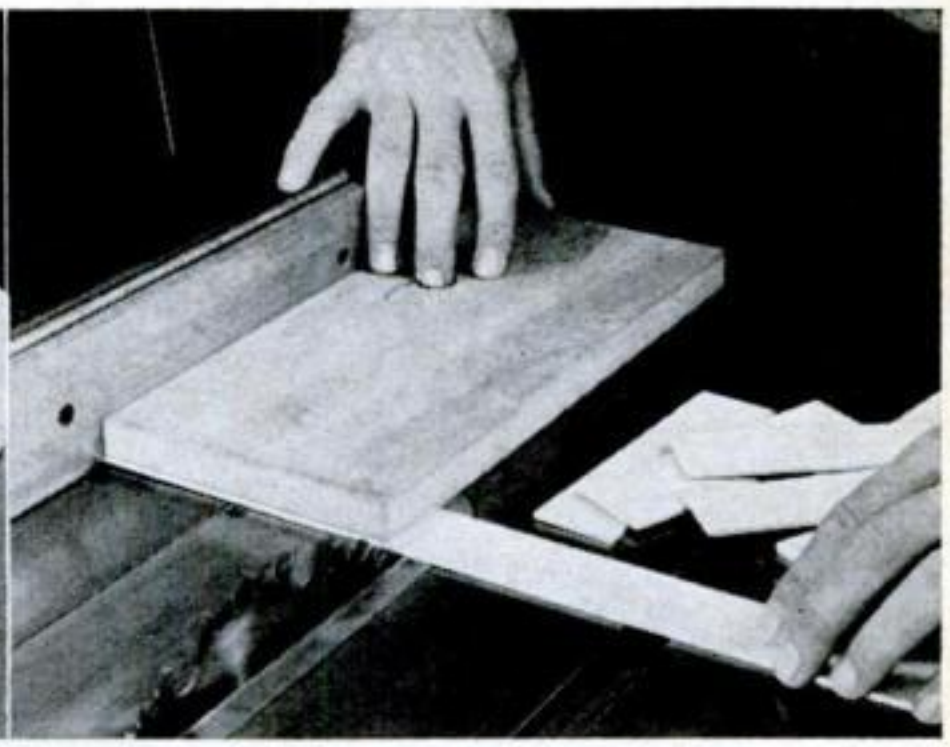
Miter jig is a handy permanent accessory. To use it, you must first cut the frame pieces to length. When using shaped stock which can't be flipped to cut both ends with the jig in the same position, just flip the jig and use the fence on the other side of the blade.



Odd-shaped pieces, such as these octagons, can be cut from squares nestled in a notched jig so corners can be removed. Lay out notch with a square and cut out on a jigsaw or bandsaw.



Plywood splines and other thin pieces that might splinter or feather can be cut this way. Make the jig as wide as the pieces must be long, and then make a shallow rabbet in one end.

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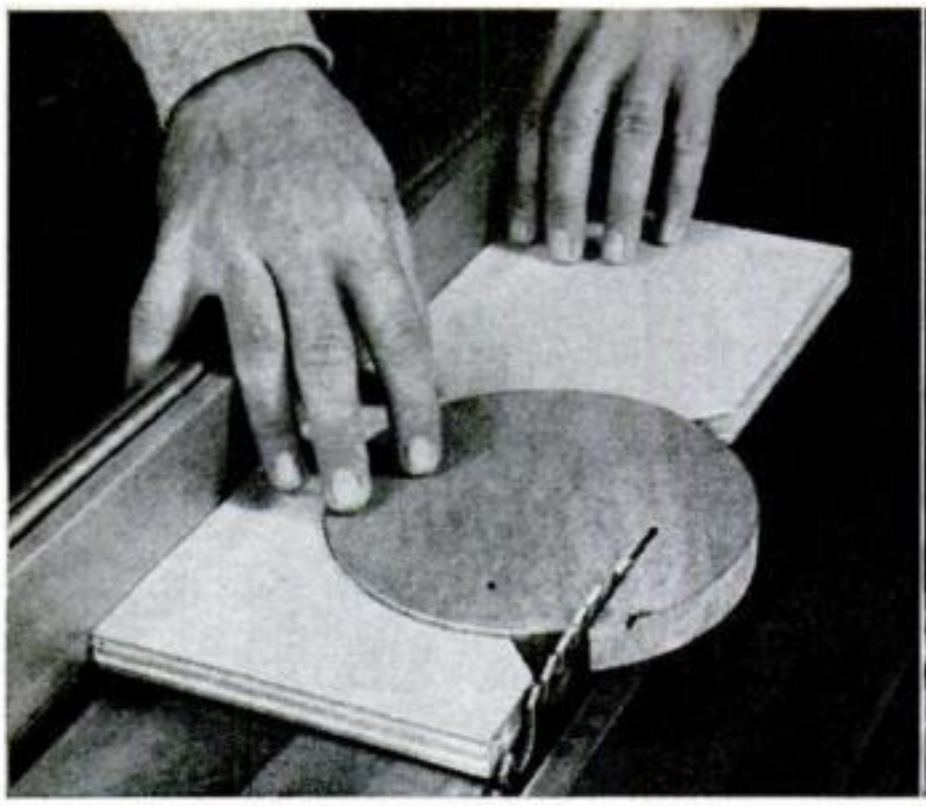
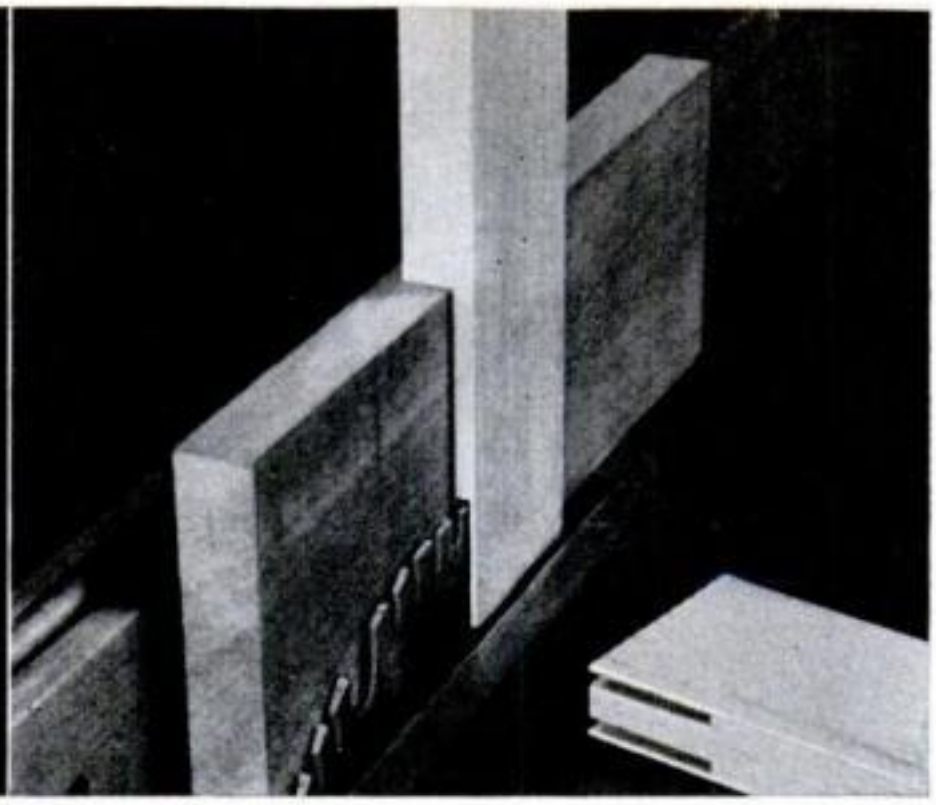
Urheberrechtlich geschütztes Material

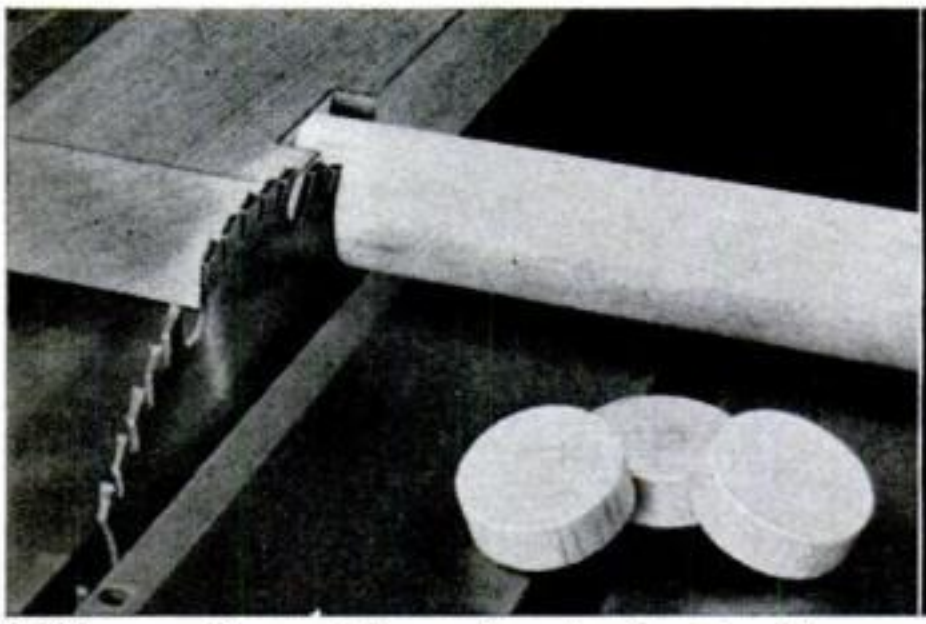
Jigs are the answer when you must cut odd shapes on a table saw



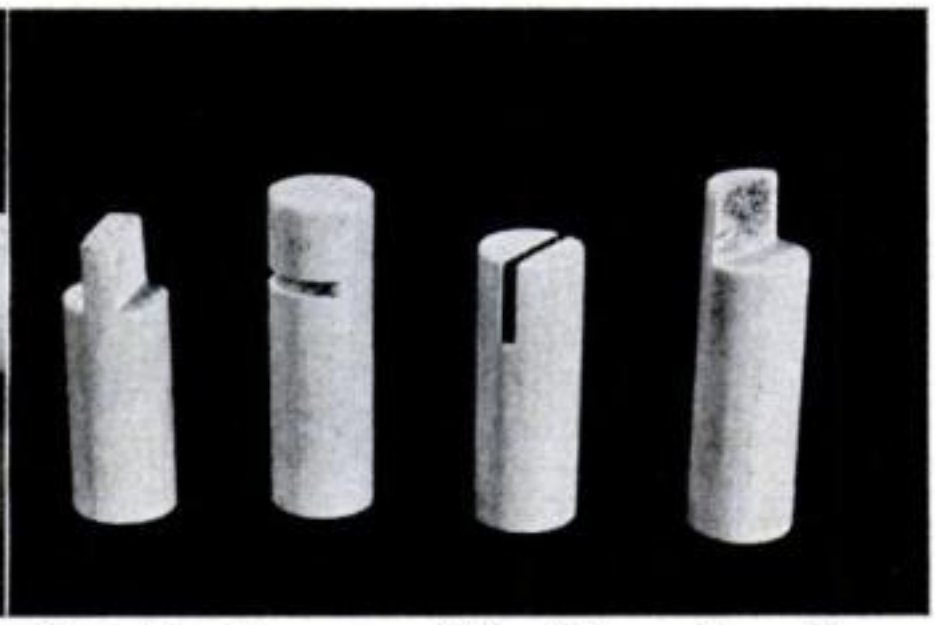
Cutting sections from disks is easier with a notched jig. Hold disk firmly while cutting to prevent turning. A V cut works as well but is more difficult to control while cutting.



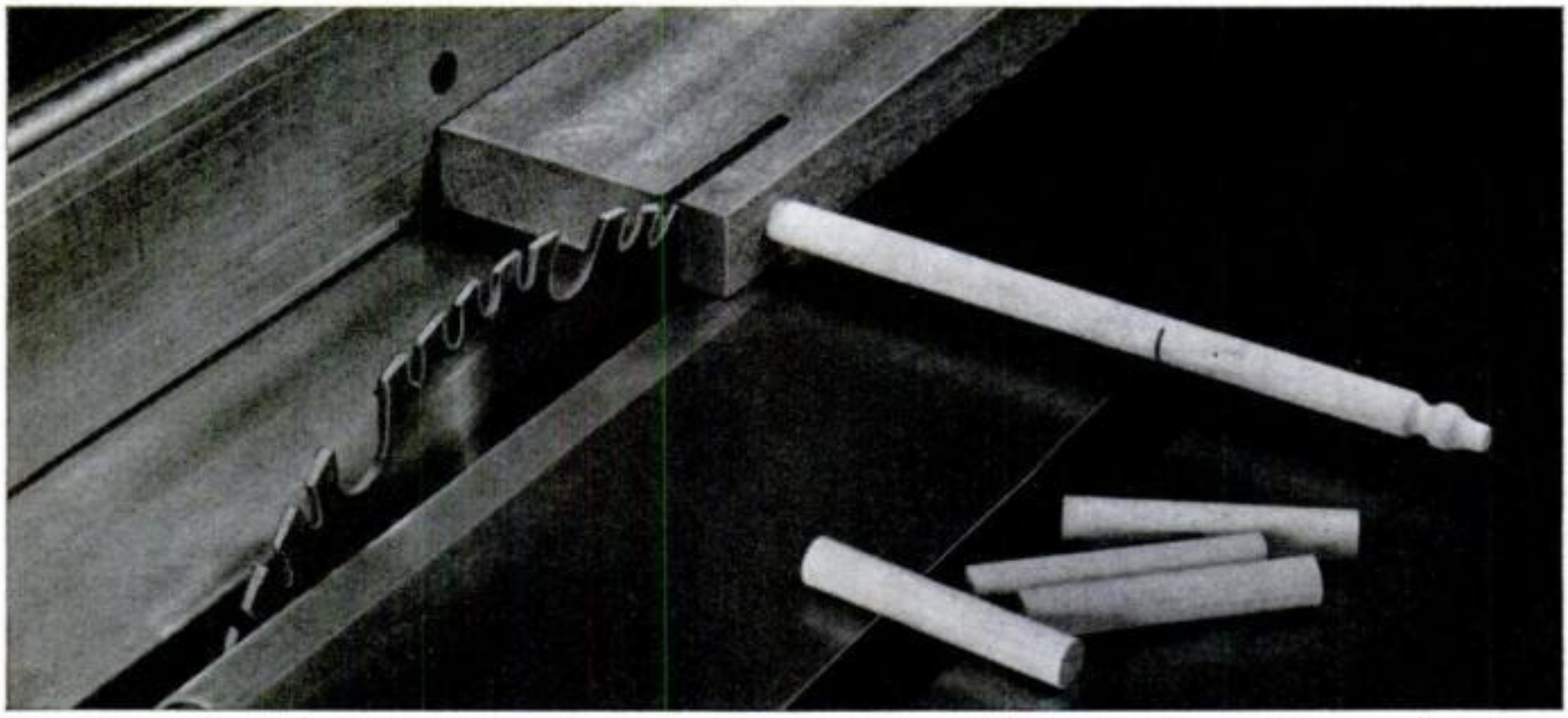
Make cheek cuts for tenons or lap joints with notched jig riding on edge. Dado the jig so stock fits snugly. Make shoulder cut with stock flat on table and feed with the miter gauge.



Disks can be cut from dowel, closet pole, or lathe-turned cylinders. The notch is a dado just wide enough to hold the stock firmly and as deep as the thickness of the required disks.



Cuts like these are difficult to make with accuracy and safety without using a notched jig. Usually the "notch" is simply a hole to hold the cylinder in the right position for the cut.



Dowels can be cut to length by feeding with a miter gauge, but you know how those little cylinders go flying around. This jig lets you cut accurately and with a minimum of feathering. A finger hole in the jig will make it easy to pull back the jig after the dowel is cut. ■ ■

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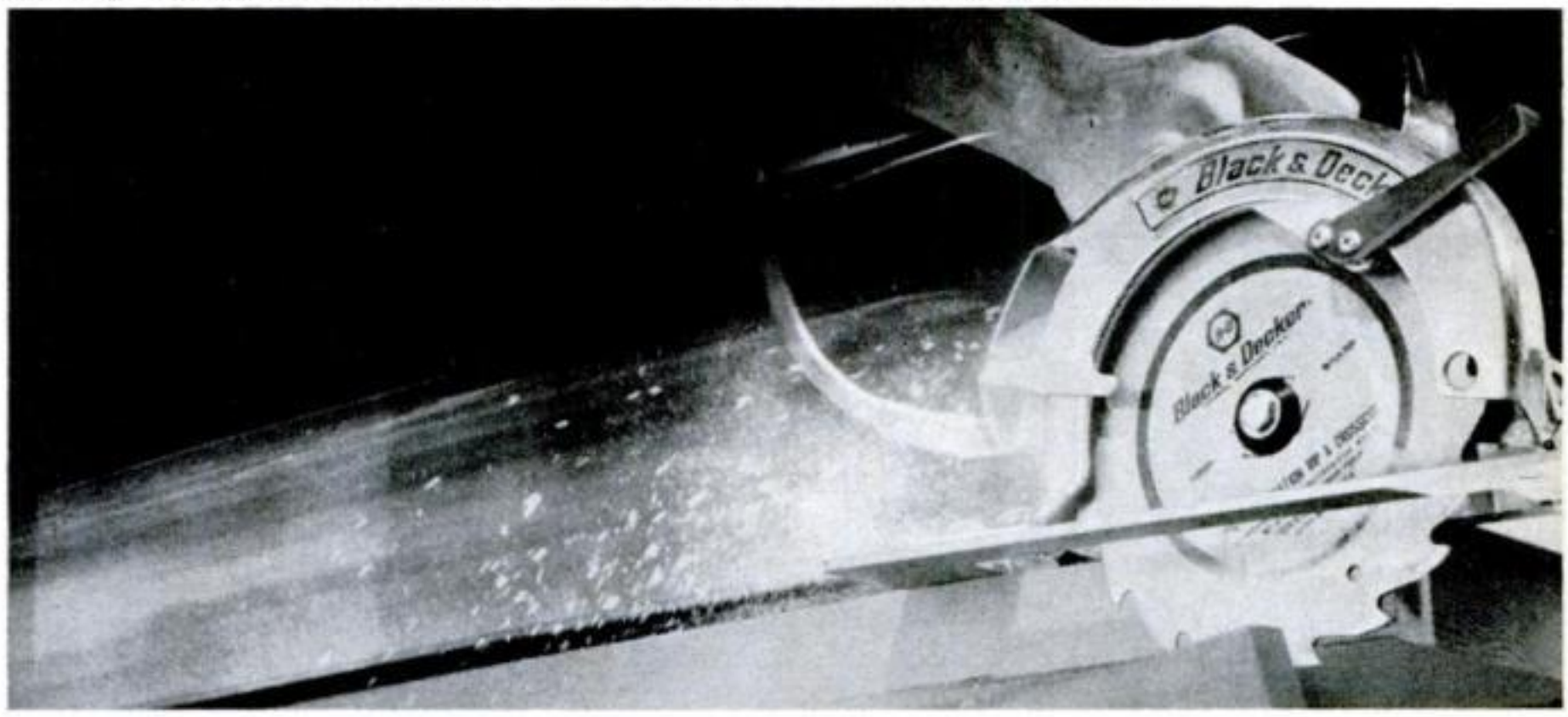
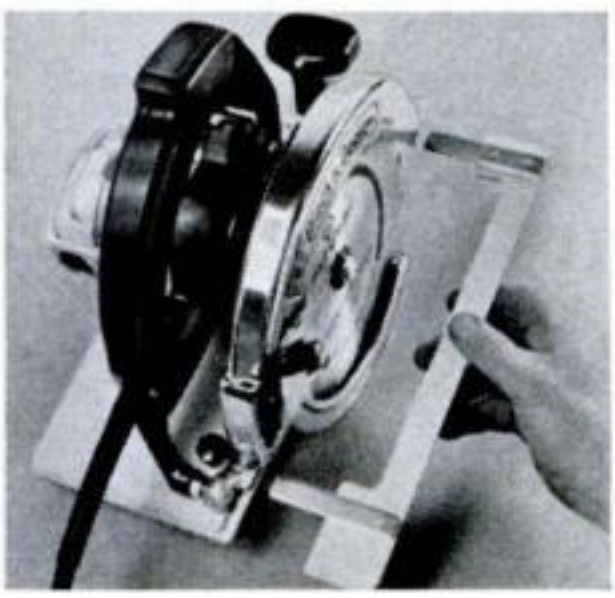
SHOP TALK

By Robert P. Stevenson

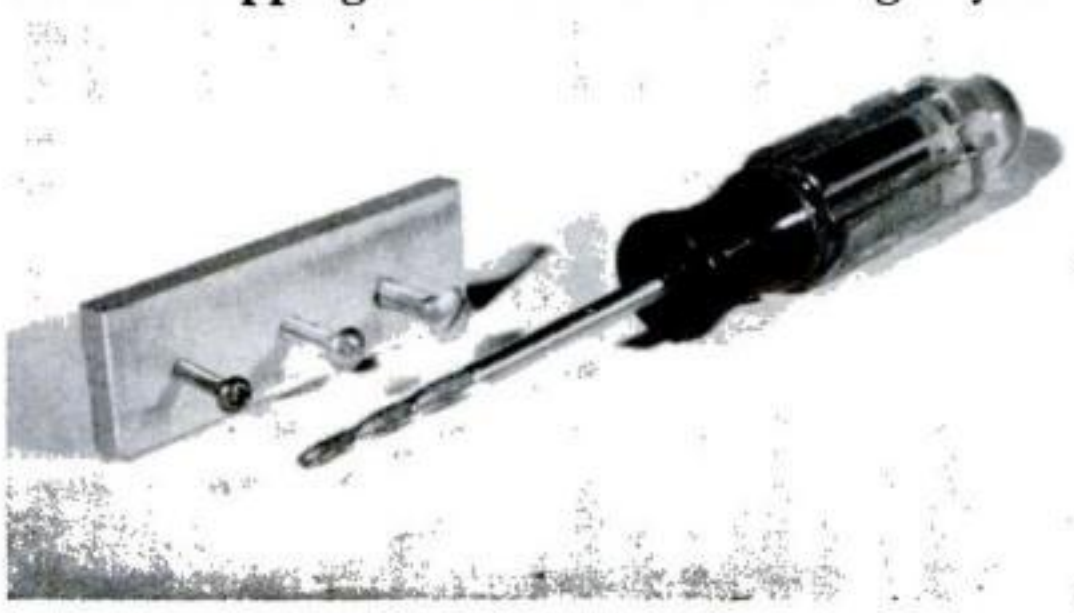
New portable saw stops in a flash. The trick? Trolley-car brakes





The photo above shows what happens when you take your finger off the trigger at the end of a cut with a new Black & Decker portable saw. The blade stops immediately. The company achieved this safety feature by incorporating into the saw a system that's basically the same as the braking system that halted electric trolleys in a bygone era. When the switch cuts power from the motor, the same action changes the internal circuit so that the motor in effect becomes a generator. The generated current tries to make the motor run in reverse, resulting in a braking action. The brakes are on four B & D professional saws, all with detachable shoes (left).

Here's a tapping tool that's worth adding to your tool chest



Three tapping diameters and a comfortable ridged handle make the Poly-Tap one of the handiest tools a home mechanic can have. It will cut 6-32, 8-32, or 10-32 threads in holes of the correct tapping size. Equally important, it will clean out marred threads and restore damaged threads (provided enough metal remains) of these sizes. It's chrome treated to resist rust. Sears has it for about $1.60.

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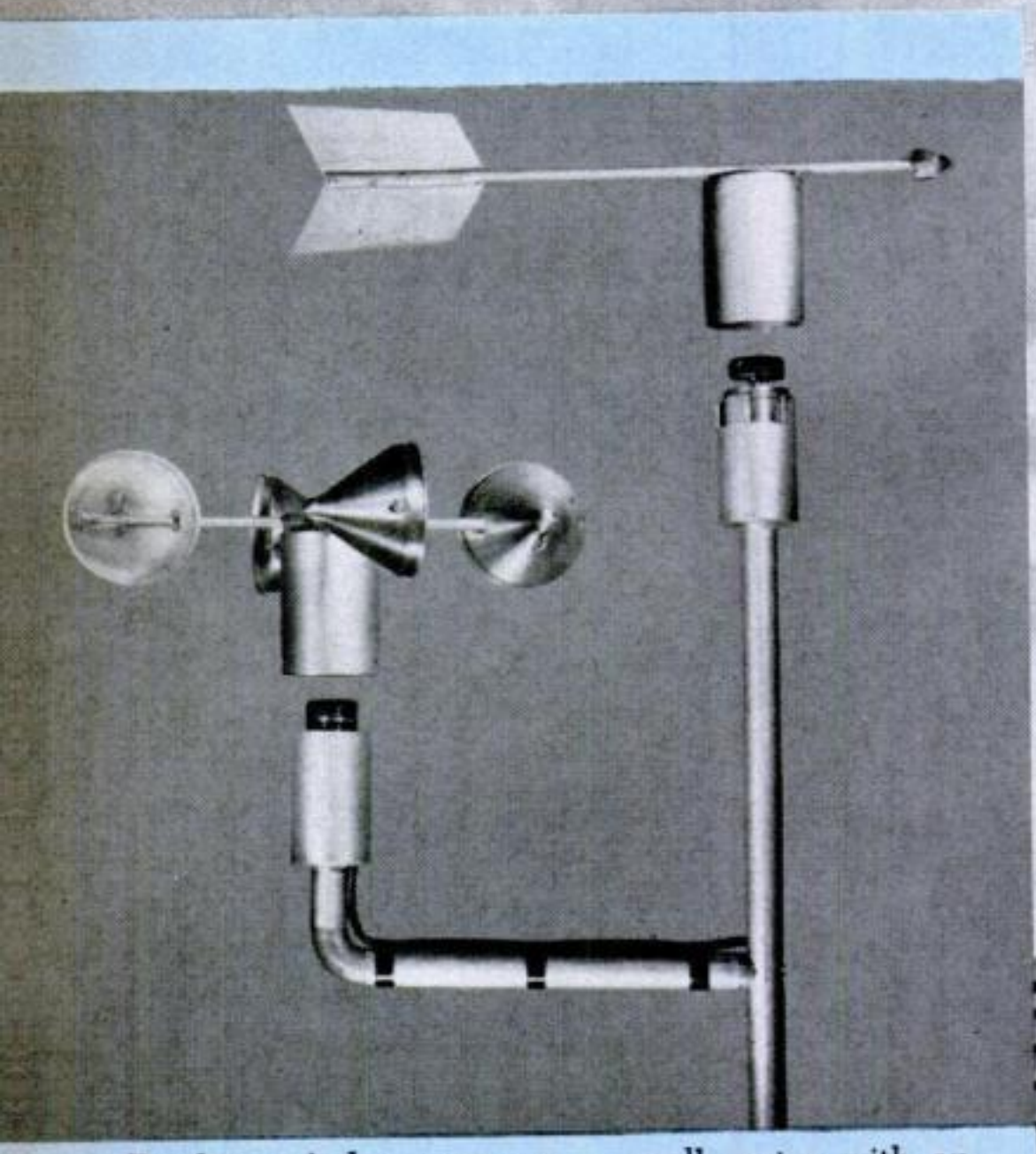
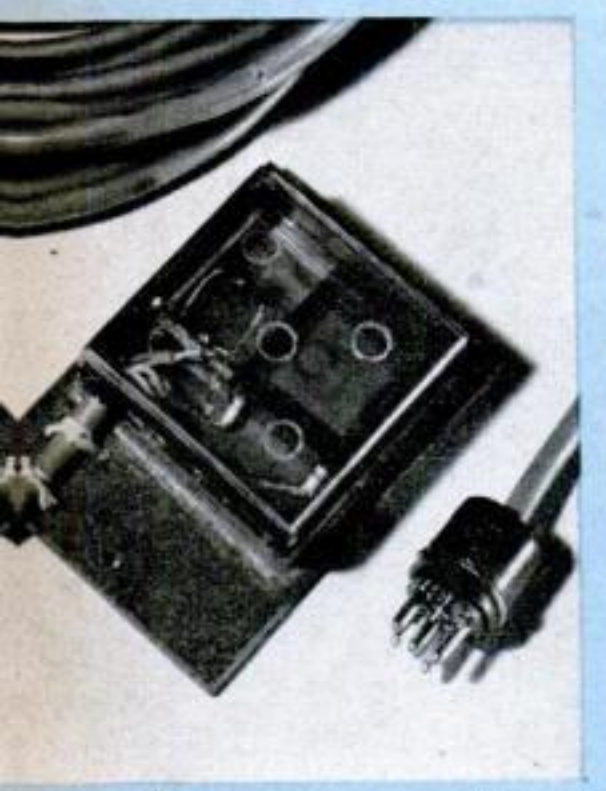
PS PROJECTS

Home-built gadgets on top of the roof send the latest weather information to instruments on your living-room wall.

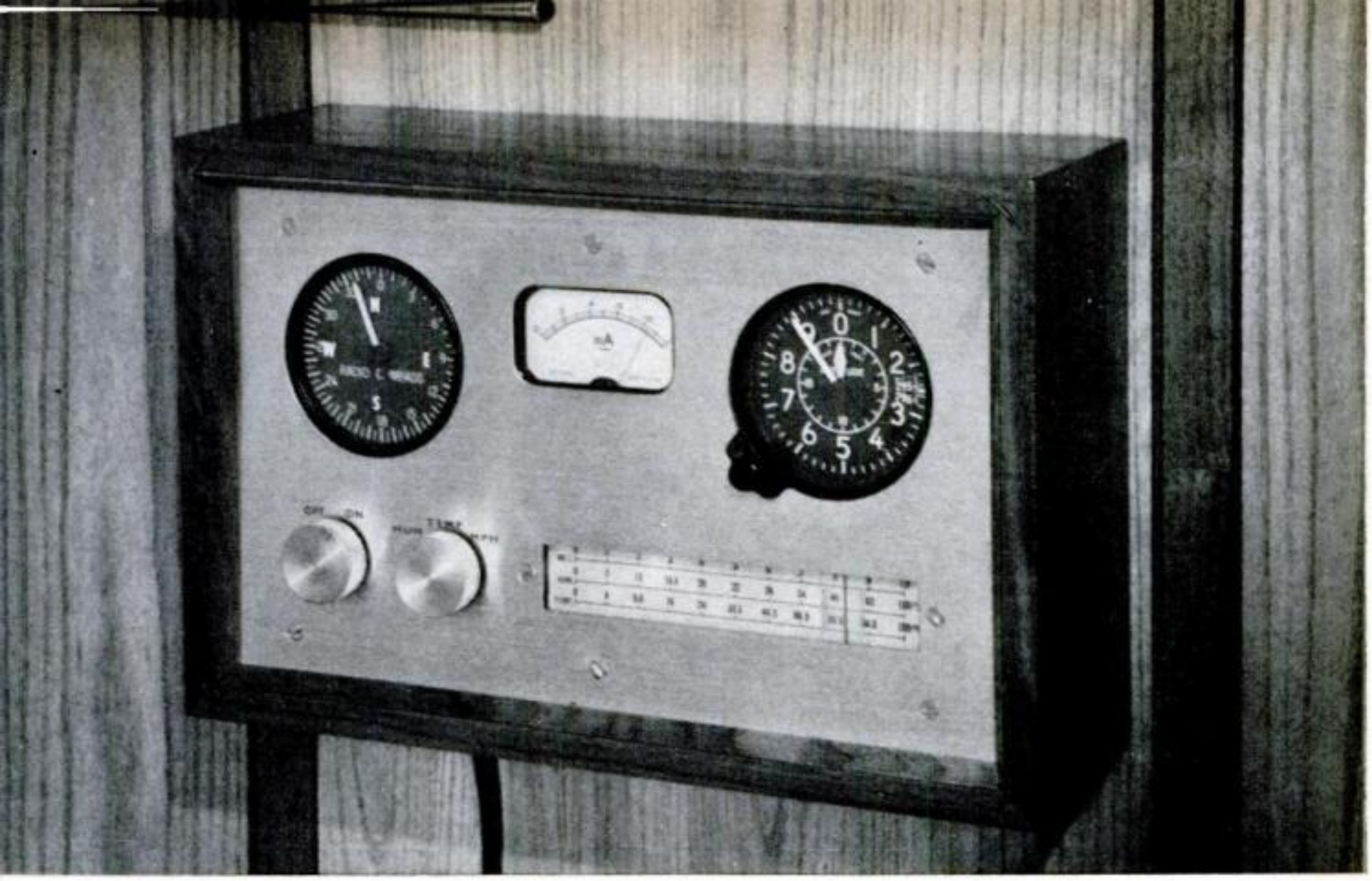
By
Howard G. McEntee
and Harry Walton



Rooftop wind sensors are a small motor with an anemometer head made of funnels, and a selsyn on which a weather vane is mounted. Small shield cans pushed up on the electrical units, and big ones fastened to the wind heads, keep out rain. The mast, 8′ of ¾″ aluminum tubing, has a branch made with aluminum T butt and elbow fittings.


HYGROPAK— CONNECT TO PINS WITH CLIPS FROM 7-PIN MINIATURE SOCKET
THER-MISTOR
SMALL LUG STRAP
PLASTIC BOX— FIVE 1/8" HOLES IN COVER
BIND CABLE
1/8" HARDBOARD

Temperature and humidity sensors are housed in a ¾″-deep, 2¼″-square plastic box with holes in its cover. It is cemented to thin hardboard. Four leads from the thermistor and Hygropak are soldered to a four-pin plug for connection to the chassis. Box is mounted horizontally, holes down.



Be Your Own Weatherman

EVERYONE has a stake in the weather. Sports, outdoor work, outings, and how to dress the children for school all depend on whether there's sun, wind, or storm. The sooner you know how the day is shaping up, the better you can plan it.

This weather station brings up-to-the-moment information right into the house. Turn a switch in your living room or den, and dials tell you the speed of the wind, whether it's gusty or steady, its direction, relative humidity, and barometric pressure. You can spot changes when they begin.

Remote-reading weather instruments like these are usually expensive. But with surplus equipment that sells for a fraction of original cost, you can make a weather station for about $50.

Most weather information requires a sensing unit outdoors. This is wired to an indoor device. The exception is barometric pressure, which is the same indoors as out.

• Wind speed is measured by a home-made anemometer head (four cups on crossbars, such as you see on airport towers). This turns a tiny permanent-magnet motor, which acts as a generator. Its electrical output is read as miles per hour. Gusts appear as fluctuations on the meter.

• Wind direction is sensed by an ordinary weather vane. This swings the shaft of a motorlike device called an autosyn or selsyn. A similar unit inside is connected to the one on the roof, and both are supplied with low-voltage AC. As the roof selsyn turns into the wind, the other follows in exact step, so wind direction can be read from it on a compass dial.

• Temperature is sensed by a thermistor —a unit that changes resistance with the temperature. The current it passes is read on the same meter used to indicate wind speed, but as degrees.

• Relative humidity is similarly sensed

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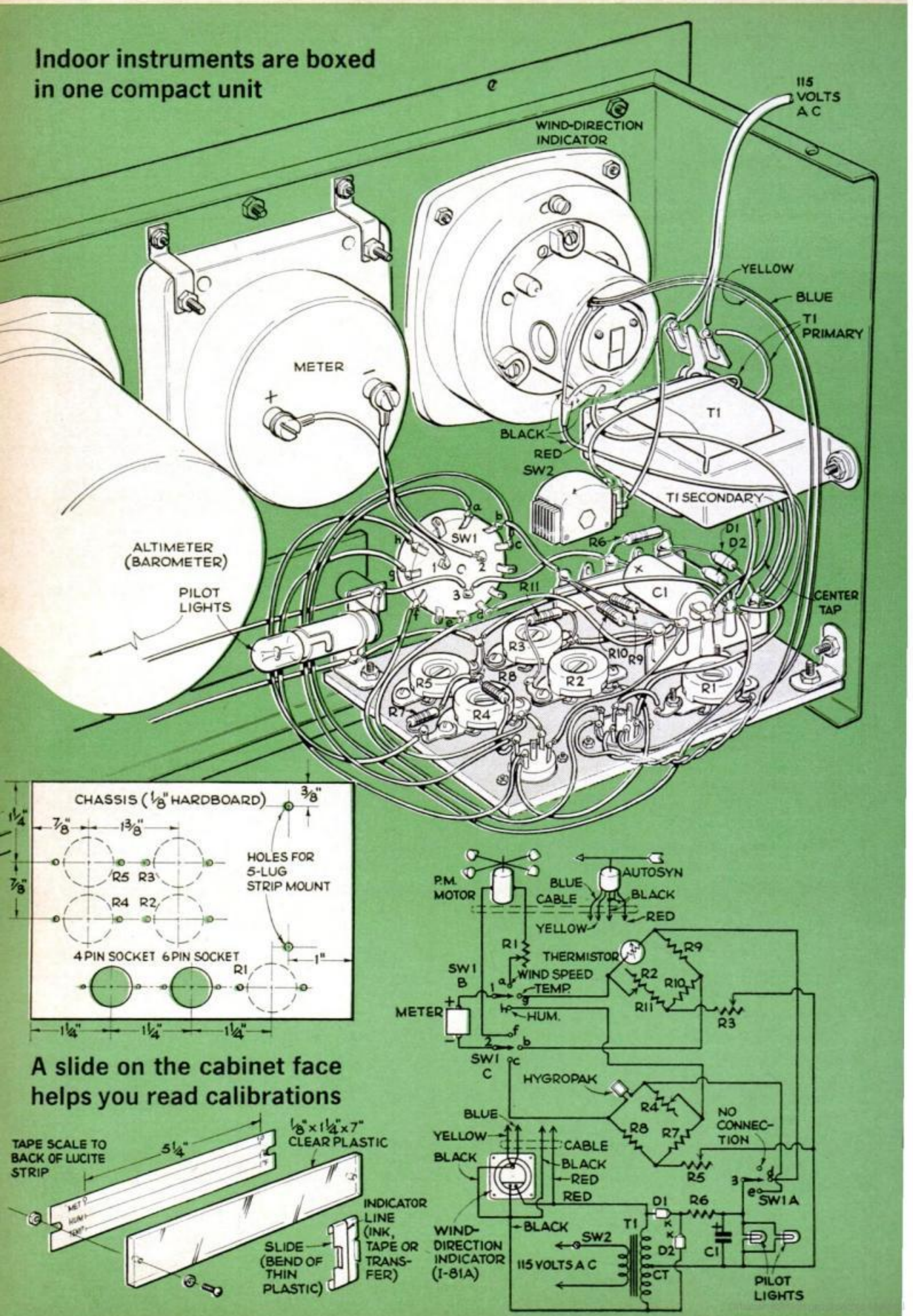
Indoor instruments are boxed in one compact unit



A slide on the cabinet face helps you read calibrations

TAPE SCALE TO BACK OF LUCITE STRIP
5 1/4"
1/8" x 1 1/4" x 7" CLEAR PLASTIC
INDICATOR LINE (INK, TAPE OR TRANS-FER)
SLIDE (BEND OF THIN PLASTIC)

by a unit called a "Hygropak." Its current is also read on the meter, as a percentage.

● Barometric pressure is shown very accurately by an aircraft altimeter (which tells a pilot how high he is by measuring air pressure). The main dial reads feet, and a smaller one inches of mercury. For weather use, the altitude needle is set at the height of your house location; the small dial then shows barometric pressure. The direction in which you must reset the needle to your altitude (it will shift as barometric pressure changes) shows whether the barometer has risen or fallen.

A used altimeter will serve. FAA rules require they be checked for aircraft, but an unchecked one of low maximum altitude will do for weather use. Be sure it's a sensitive altimeter; so-called simple ones are no better than home barometers. Your local airport is a possible source. A home barometer can also be used, if necessary.

Turn the wind-speed sensor, a small high-quality ball-bearing motor, and you'll feel a steplike resistance caused by magnetic drag. This must be reduced for sensitivity to light winds. Peel off the label at the back to expose the field magnet. Place a few iron washers or punchings to a total thickness of ⅜" on the end of the magnet to "short circuit" its field. You should now feel little or none of the steplike resistance. Put weatherproof cement at the edges only of the disks or washers to hold them, not between.

To further reduce drag, remove each brush and cut out the copper braid inside the tiny spring. With the brush touching the commutator, clip the exposed part of the spring off $\frac{1}{32}$" above the brush holder. Also reduce brush area by half by notching it across the middle with a needle file, as in the drawings. Be sure to replace brushes so that the concave end seats on the commutator properly. Run them in by driving the motor 15 minutes on about six volts of *direct* current.

Make the rotor or anemometer of four aluminum funnels and ¼" aluminum arrow-shaft tubing. Cut funnel spouts to ½" length, insert a steel rod, and hammer them closed over this. Drill a ¼" and a $\frac{3}{32}$" hole in each funnel, slip two on each piece of tubing, flatten the tubing ends, and bend them to fit the funnels. Rivet these on each shaft to face in opposite directions.

File halfway through each shaft for a cross-lap joint, making certain that when assembled all the funnels will face either clockwise or counterclockwise. Hang the rotor by a thread and file the funnel edges or attach metal cement to balance it.

For the wind vane, slit one end of a 12" length of ¼" tubing 3½" deep and rivet in a vane cut from flashing aluminum. Drill a ¼" hole in part of a fishing sinker and cement it to the other end. Hang the vane 3½" from the pointer. Balance it by filing metal off the sinker if it's at the heavy end, or adding solder if it's light.

Make mounting hubs for the wind-speed motor and the selsyn of drumlike metal

CONTINUED

PARTS LIST

Variable resistors, Clarostat series 39: R1, R5—1,000 ohms; R2—5,000 ohms; R3—2,000 ohms; R4—100 ohms
1-watt carbon resistors: R6—10 ohms; R7, R8—47 ohms; R9—220 ohms; R10—100 ohms; R11—2,700 ohms
C1—50-mfd., 25-volt electrolytic capacitor
T1—12-volt center-tapped, 1-amp transformer (Radio Shack Corp., 27L1505)
D1, D2—low-cost silicon diodes (Lafayette 19G5002)
SW1—3-pole, 4-position rotary switch (Lafayette 30G4020)
SW2—single-pole, single-throw rotary switch
Pilot lights—two No. 47 bulbs and sockets
Meter—1 ma., 3" square (Lafayette 99G5040)
Thermistor—1,200-ohm Veco 31D7 (Newark Radio Corp. 29F139)
Hygropak—HA-26 (Photo-Crystals, 605 Prairie St., St. Charles, Ill.)
Autosyn—Oster 2G2151 (Herback & Rademan Inc., 1204 Arch St., Philadelphia 7)
I-81-A—direction indicator (Fair Radio Sales Co., Box 1105, Lima, Ohio 45802)
Cable—eight-conductor, 100' spool (Lafayette 32G1468)
Shield cans—two Miller S-41, two Miller S-31)
Instrument case—4"-by-7"-by-12" aluminum (Lafayette 12G8395)
Lug strips—two 5-lug, two 2-lug
Four-prong connectors (Lafayette, socket 32G1964, plug 32G1970)
Six-prong connectors (Lafayette, socket 32G1966, plug 32G1972)
Knobs for hubs (two) with ¼" shaft hole (Lafayette 32G2408)
Mast—¾" aluminum tubing 8' long (Reynolds 8A); T-butt fitting (Reynolds 51); 90-deg. elbow (Reynolds 54)
Wind-speed motor-generator 1025 (Surplus Center, 900 O St., Lincoln, Neb. 68501)
Sensitive aircraft altimeter (Palley Supply Co., Inc., 2263 E. Vernon, Los Angeles 90058)
Dwyer hand wind meter, for wind-speed calibration (Emund Scientific Co., Barrington, N.J.)
Miscellaneous—3' of ¼" arrow-shaft aluminum tubing; two knobs for panel switches; line cord; 6-32 screws, nuts; aluminum mounting clips for mast; four aluminum funnels 2½" diameter; flashing aluminum; plastic strip for slide rule; plastic box for humidity and temperature sensors.
Parts that may be hard to get are available from Techni-Kits, Inc., 350 Broadway, NYC, for $14.95, plus $1.25 postage. Ask for kit 620, motor 1025, autosyn 2G2151, radio-compass indicator I-81-A, center-tapped transformer T7L1505, thermistor (1,200-ohm) 31D7, Hygropak HA-26

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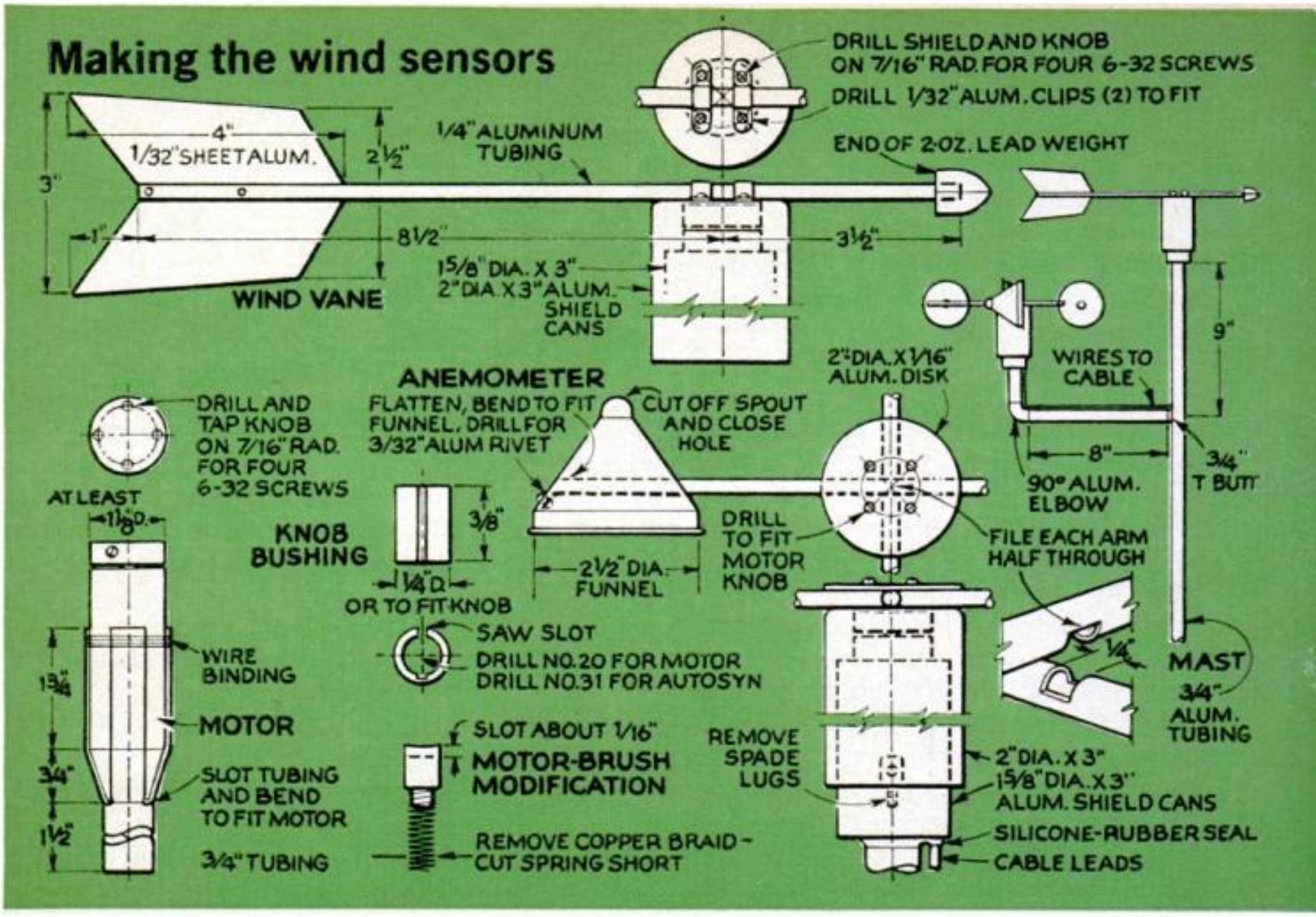


radio or TV knobs having ¼" shaft holes and setscrews. Drill and tap four holes in each hub as shown in the drawing, taking care to space them accurately.

Bushings are needed to fit the hubs to the motor and selsyn shafts. If you haven't access to a lathe, spin ¼" brass rod in a drill press, an electric drill, or even a hand drill fastened in a vise. Scrape a dimple in the end to center a drill; then drill out to fit the shaft. Bushings might also be assembled of telescoping brass tubing, available at hobby shops. Slit the bushings so that the setscrews will clamp the knobs to the shafts.

The roof mast should be long enough to hold the wind instruments well above the roof ridge. Drill four equally spaced ¼" holes 2" from the ends of the mast and its vertical branch member. Saw slots from the ends to these holes. Cut a ¾" hole in the bottom of the smaller shield cans and slide them, open end up, over the mast and branch. Before assembling the mast, run an eight-conductor cable through it. Take two wires out at the branch.

Bend the slotted tubing segments to fit the anemometer motor and selsyn. Use epoxy cement and a tight binding of copper wire to fasten these in. Slide up the shield cans and cement them in position.

Drill the bigger shield cans to match the tapped holes in the sensor hubs. Mount the wind vane with two clips and the anemometer with an aluminum disk, the shield cans being underneath and overlapping the smaller cans. Shafts must turn freely. Seal all openings, joints, and screws with epoxy cement or silicone rubber.

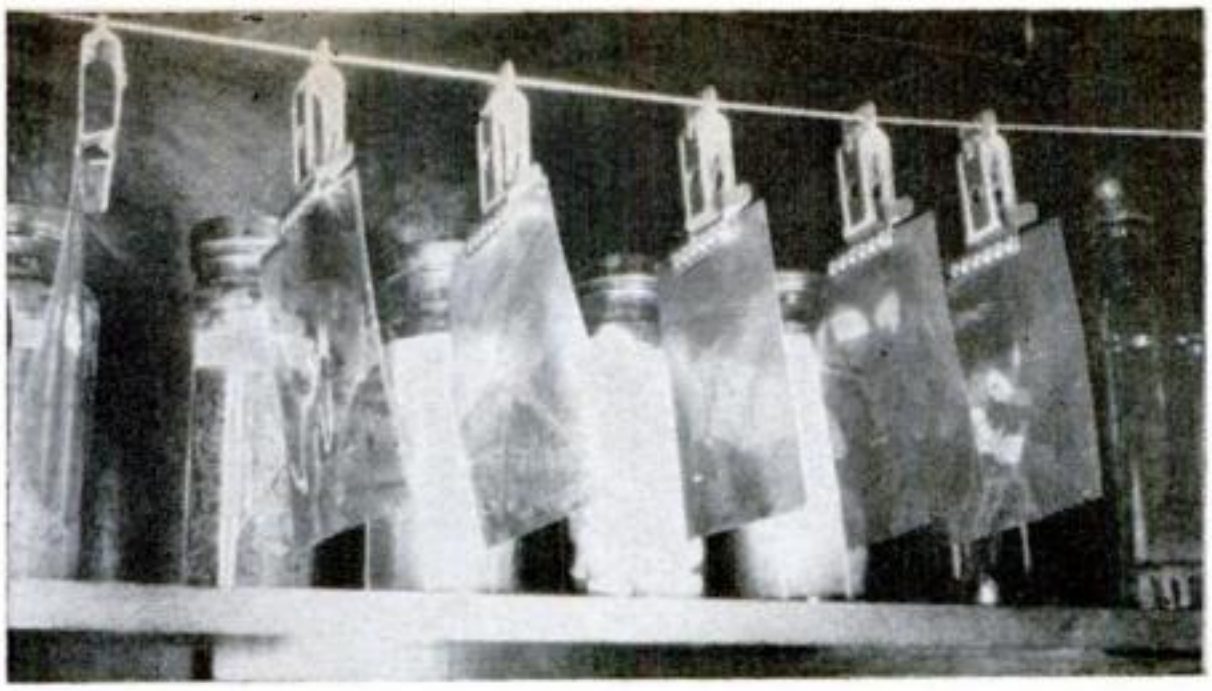
Temperature and humidity sensors are fastened in a small plastic box, which is cemented to a piece of hardboard for mounting. The Hygropak must be in a red case. Blue-case units are of high resistance and won't do. Be careful not to touch the sensitive surface with the fingers, and don't blow cigarette smoke on it. Fasten the unit with contact cement, leaving the sensitive surface exposed.

Drill holes in the box cover for free air movement. Attach four color-coded wires to the thermistor and Hygropak. After calibrating, mount the box in a sheltered spot—under a porch roof, for example—the Hygropak surface down.

The wind-direction reader may be a second selsyn, or a I-81-A compass unit that

[*Continued on page 170*]

Urheberrechtlich geschütztes Material

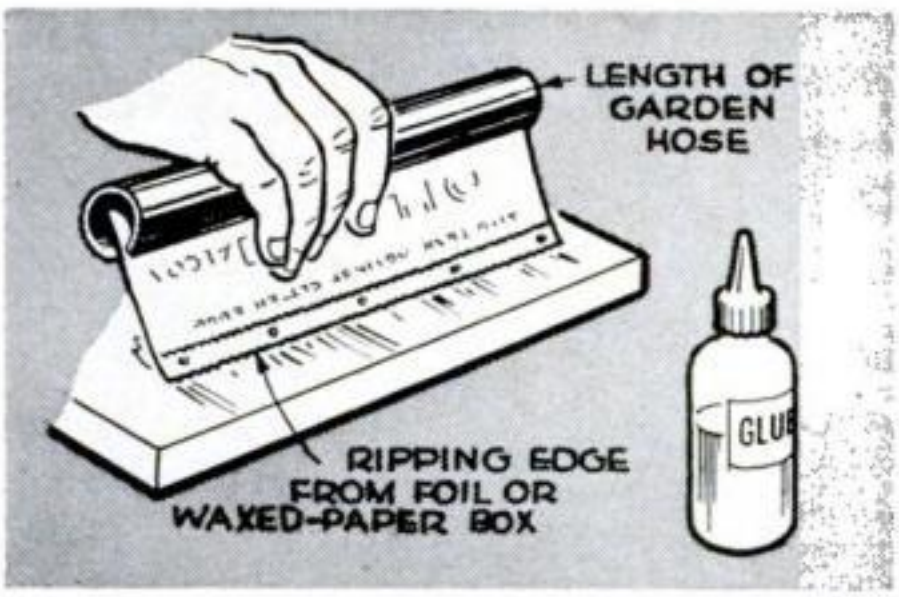


Bead chain makes nonskid film-clip line

Do your film clips and hangers slide to the center (or a low end) when you hang them on a line to dry? Here's a simple cure: Use bead chain (photo above). Besides keeping the hangers apart, it won't stretch. Most hardware stores carry it.—*W. Thomas, Buffalo, N.Y.*

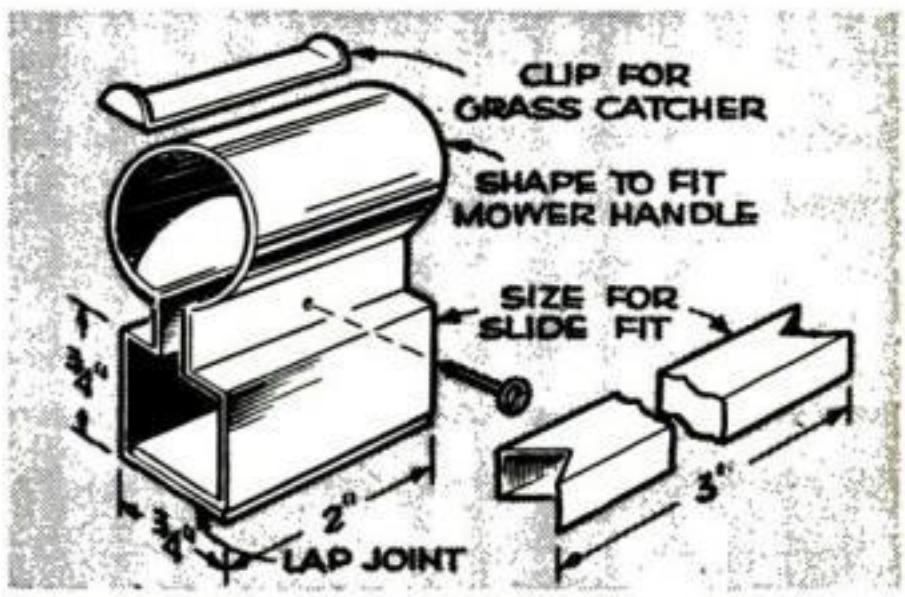
Juice can makes welder more convenient

A large fruit-juice can mounted on your welder (right) with No. 10 sheet-metal screws makes a handy spool for secondary cables, and holds ground clamp and electrodes. When using the welder you can safely drop hot ends of used electrodes in the can.—*S. White, Las Cruces, N.M.*



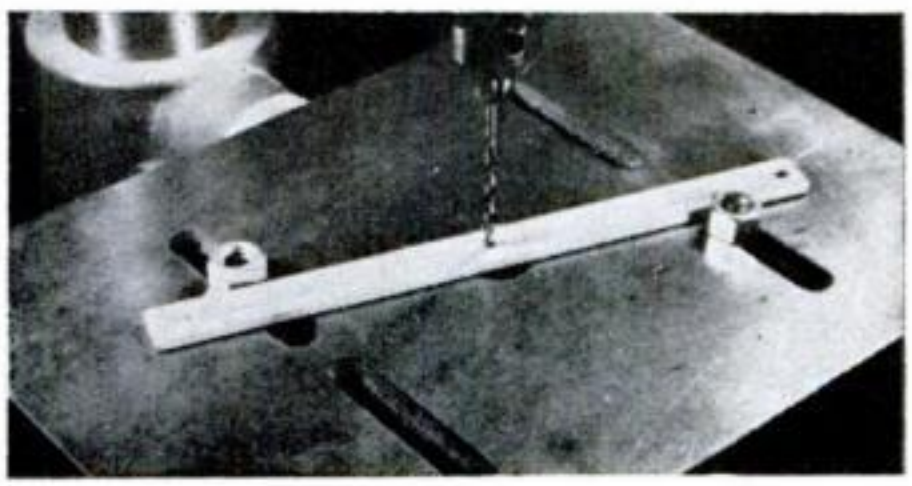
Disposable glue spreader speeds work

The saw-edged metal tear strip fastened to a box of aluminum foil or other kitchen wrap makes a good glue spreader. Leave a double thickness of cardboard on the strip for a handle. Stiffen it with a split length of garden hose.—*E. Wieczorek, Chicago.*



Clip holds reel mower safety stick

A stick is the safest way to turn back the blades of a reel mower when it jams on a pine cone or other obstruction. Carry a 3′ notched stick in this clip (shown above) on your mower handle; use it to mount a grass catcher, too.—*C. G. Faubion, El Reno, Okla.*



Nuts and bolts make drill-press guide

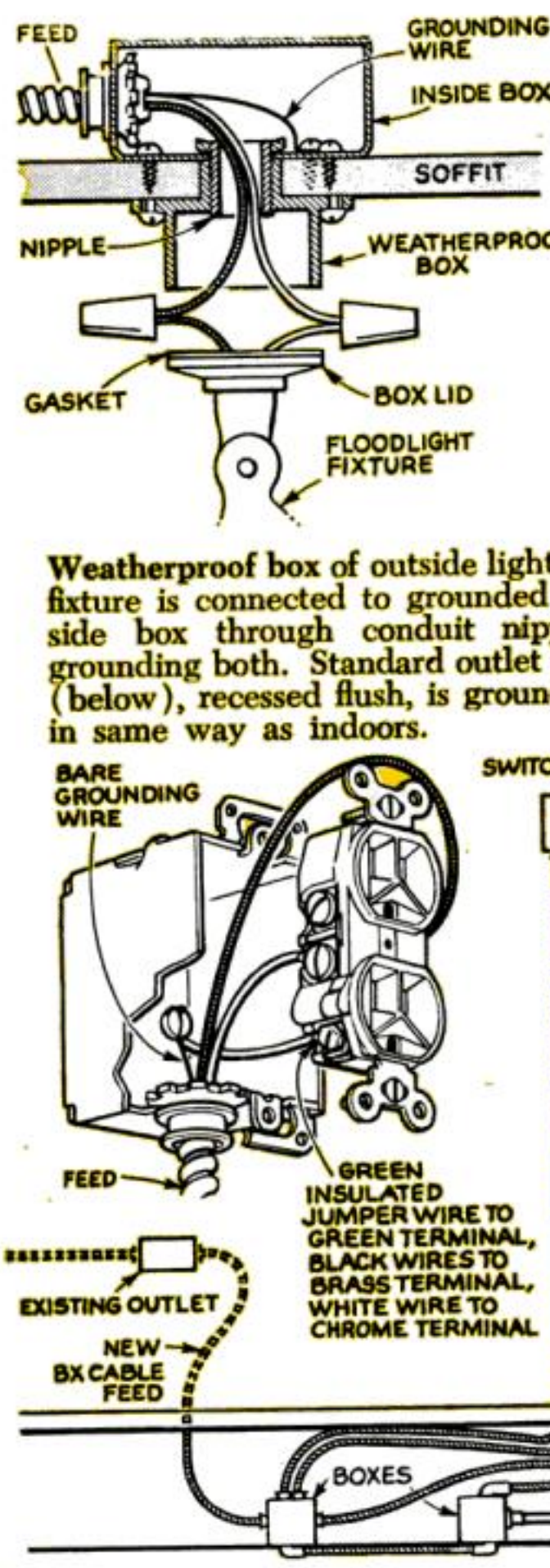
Avoid having to clamp each one of many similar workpieces when drilling: Make a drill-press guide. Nuts and bolts through the clamping slots (left) keep the drill from turning the work; by tightening them in the correct position, you also can use them to align work under the drill.—*R. J. DeCristoforo, Los Altos Hills, Calif.*

Urheberrechtlich geschütztes Material

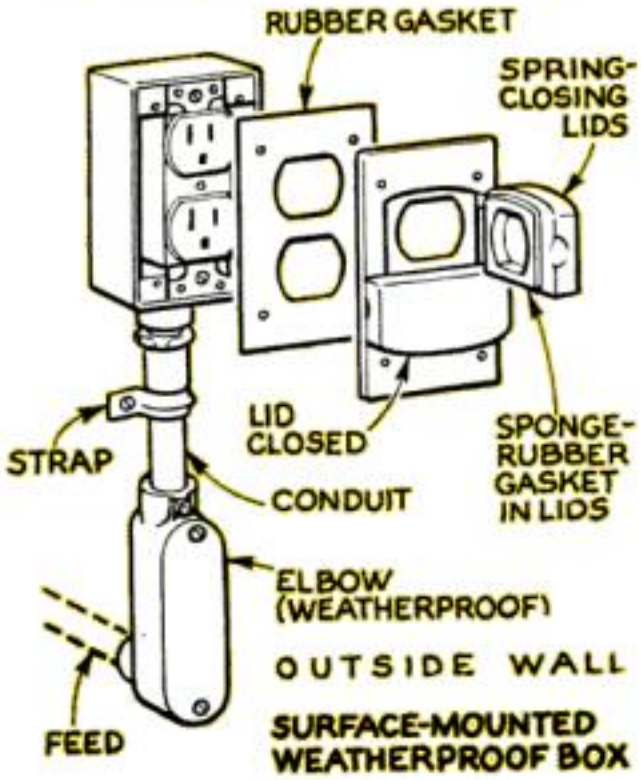
PS Money-Saving Series:

Improving

Weatherproof box of outside lighting fixture is connected to grounded inside box through conduit nipple, grounding both. Standard outlet box (below), recessed flush, is grounded in same way as indoors.

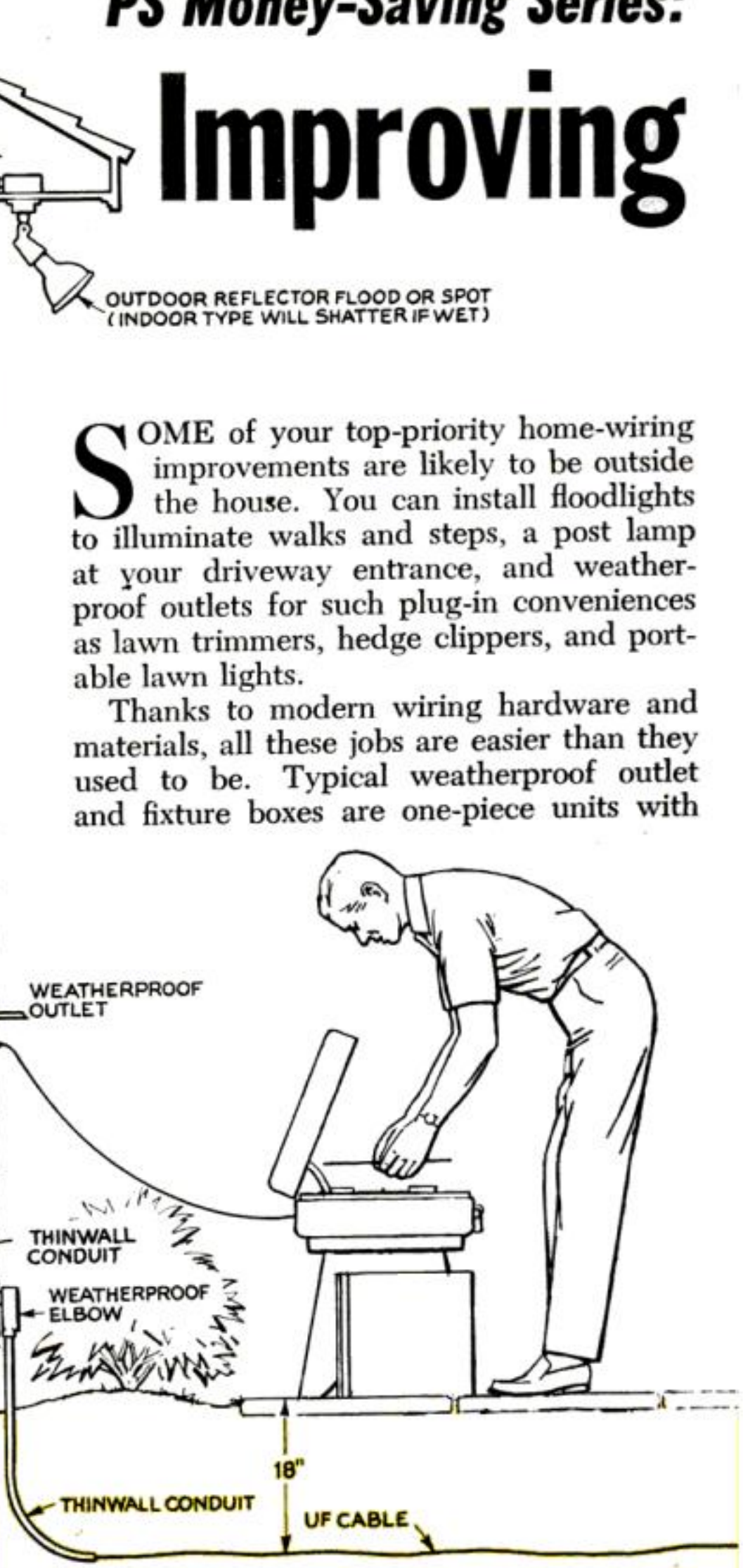

BARE GROUNDING WIRE
SWITCHES
FEED
GREEN INSULATED JUMPER WIRE TO GREEN TERMINAL, BLACK WIRES TO BRASS TERMINAL, WHITE WIRE TO CHROME TERMINAL
EXISTING OUTLET
NEW BX CABLE FEED
BOXES

If box is surface-mounted outdoors it must be weatherproof, fed through conduit from grounded indoor box. Use weatherproof cover, gasket.



SOME of your top-priority home-wiring improvements are likely to be outside the house. You can install floodlights to illuminate walks and steps, a post lamp at your driveway entrance, and weatherproof outlets for such plug-in conveniences as lawn trimmers, hedge clippers, and portable lawn lights.

Thanks to modern wiring hardware and materials, all these jobs are easier than they used to be. Typical weatherproof outlet and fixture boxes are one-piece units with



Variety of weatherproof covers are available for use on indoor boxes recessed into outside wall as above. Outlet cover (below) designed for a padlock can eliminate an inside switch. A standard switch can be used as at right. For severe conditions, use weatherproof boxes.

WEATHERPROOF COVERS FOR STANDARD BOXES

Urheberrechtlich geschütztes Mater

Your Home Wiring

By George Daniels

THIS MONTH: How to wire your yard

gasketed covers to keep out moisture. Screw caps or hinged snap covers with foam-rubber seals shield receptacles when not in use. Floodlight sockets carry heat-resistant rubber rings that fit around bulb necks to keep rain from trickling in. If any does, drain holes at low points let it out.

The cable for underground runs and moisture-problem areas is designated Type UF (for underground feeder). It resists wear and water so well that plenty is still performing perfectly after a decade.

The receptacles you use in weatherproof boxes are the same grounding type required inside your house. If outlets are flush-mounted in the outside wall (so the box is inside the wall) you can even use an indoor-type box—much lower in price than a weatherproof one. As the wiring, too, is inside the wall, you can also use indoor cable like BX or Romex (though the saving is small).

As your first step, decide whether you want outdoor lights, plug-in outlets, or both. This decision determines how husky an existing circuit you'll need for a starting point and what size wire you'll use. Before you buy any materials, check your local code for the types approved in the area, especially the cables. Many communities simply adopt the National Electrical Code, which gives you a wide choice; others are more restrictive. Ask the electrical inspector any questions the code doesn't answer regarding your job.

Installing a post lamp. The materials and methods you use here can also be used to carry electricity to a detached garage, tool shed, or lawn outlet. As you'll probably want the switch on the first floor, you'll save money and work by beginning the run from a first-floor or basement outlet or junction box.

If it's an outlet box, it should be at the end of a cable run so only one cable leads to it. Then you can connect your new cable without exceeding the number of wires permitted inside the box (about four or five plus grounding wires in a typical wall-size box). Also, connections are easy, as end-of-run receptacles have two unused terminals. In exposed basement wiring, you

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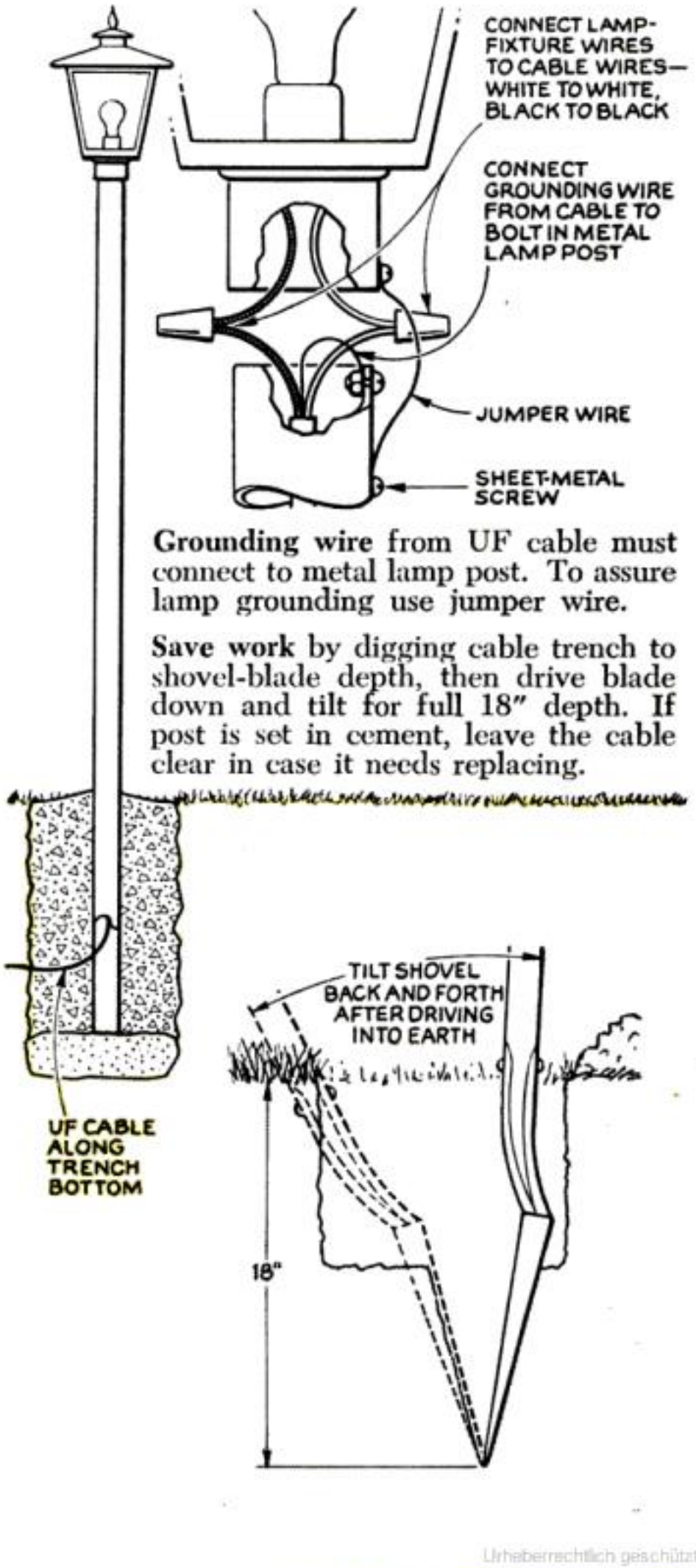
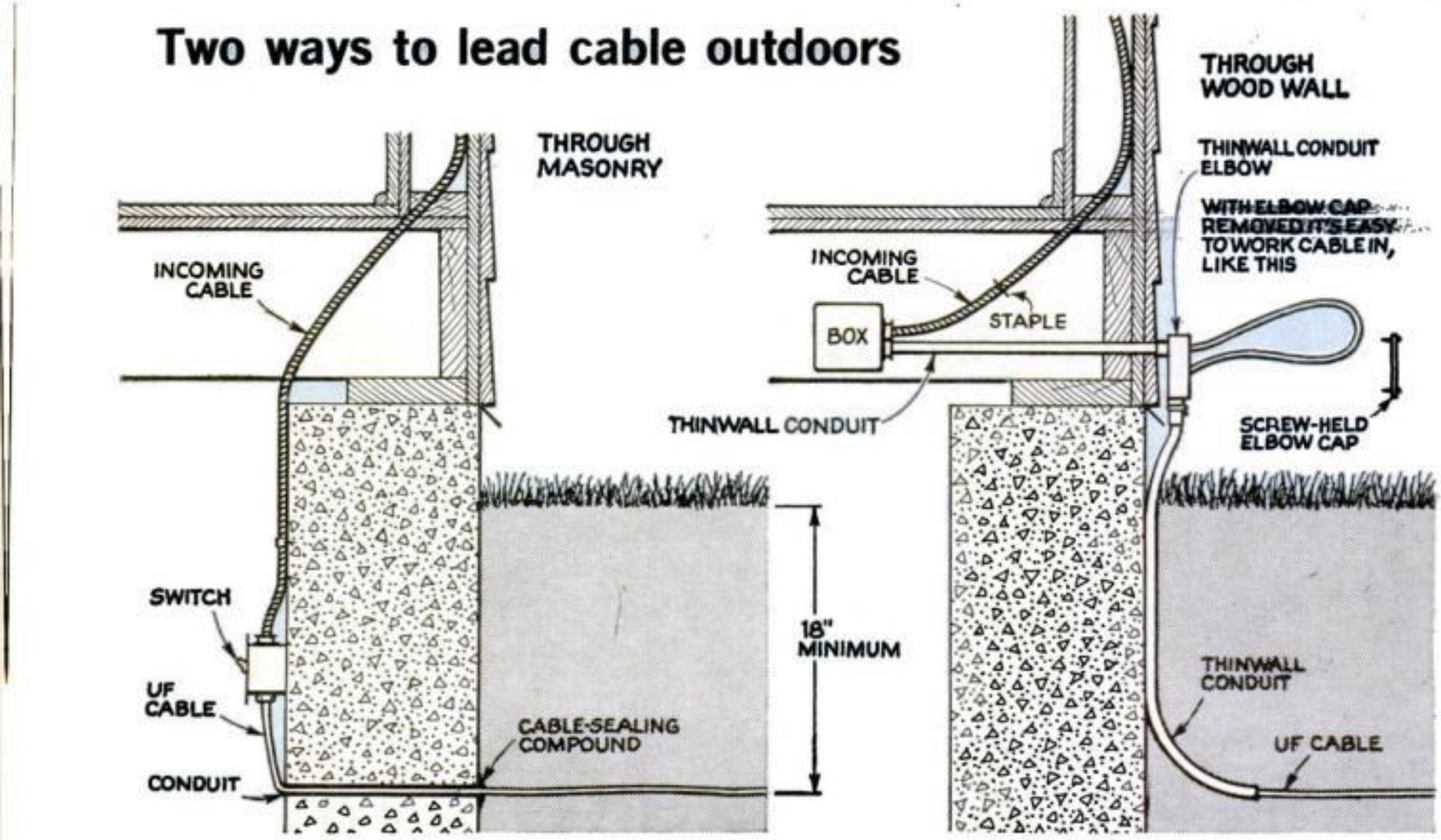

CONNECT LAMP-FIXTURE WIRES TO CABLE WIRES—WHITE TO WHITE, BLACK TO BLACK
CONNECT GROUNDING WIRE FROM CABLE TO BOLT IN METAL LAMP POST
JUMPER WIRE
SHEET-METAL SCREW
UF CABLE ALONG TRENCH BOTTOM
TILT SHOVEL BACK AND FORTH AFTER DRIVING INTO EARTH
18"

Grounding wire from UF cable must connect to metal lamp post. To assure lamp grounding use jumper wire.

Save work by digging cable trench to shovel-blade depth, then drive blade down and tilt for full 18" depth. If post is set in cement, leave the cable clear in case it needs replacing.

Urheberrechtlich geschütztes Material



can spot an end-of-run box by the single cable leading to it. Elsewhere you'll have to turn off the current and remove outlet cover plates to find a pair of unused terminals.

If you start from a junction box, unscrew wire nuts from existing splices, add your new wires, and replace the nuts. The larger the box, the more wires permitted—eight No. 14 wires in a 1½″-by-4″ octagonal type, for example. But check your local code.

If the box has built-in clamps, be sure they match the new cable. Otherwise buy a connector to match it. If you have to remove a double clamp that already holds another cable you'll need a connector to match. This is likely where BX leads to a box from which you start a run of UF cable.

In any event, don't make your starting-box connections until the end of the wiring job. This way, your house current can remain on during the work, and need be turned off for only a few minutes at the finish.

If you locate the post lamp at a driveway entrance, allow 2′ or 3′ clearance from the driveway edge for trucks or delivery vans. Mark off the shortest path to a point on the house or garage where you can lead the wiring out. You'll dig a shallow trench along this line. (You can save digging by running your wire as far as possible along the inside of the wall.)

Measure the distance from the post location to the lead-out point, through the wall, to the switch, and from there to the start-

Ground a weatherproof box as shown here by running bare wire to screw in bottom of box where water won't enter. If box has no grounding screw, drill and thread hole for one.

NEXT MONTH: Installing

Urheberrechtlich geschütztes Material

ing box. Allow for the distance the cable must run up inside the lamp post and up or down walls. Also allow 8″ for "free wires" wherever the cable enters or leaves a box or fixture, and add about five percent of the overall length for slack in the trench to take care of ground heave during winter freezes.

Type UF two-wire cable with a third "grounding" wire in it is the handiest type to use if your local code permits. (The National Code okays it, but some local codes require other types or full-run conduit.) This cable is waterproof, but must run in a continuous length from the lamp terminals to terminals at the house (in this case indoors). No splices are permitted under ground. You can use indoor cable inside the house, but you'll simplify matters by using UF from start to finish.

Going through the wall. You can lead your cable either through a masonry foundation or the wall above it. Other factors being equal, it's a lot easier to go through wood. Lead the cable through conduit and an elbow fitting, as shown in a drawing. Half-inch rigid galvanized conduit will fit snugly through a ⅞″ hole. If you want a freer fit, drill a 1″ hole. You can buy a straight nipple, threaded at both ends, to run from inner box to outer fitting. The piece that leads into the trench can be cut from a 10′ length, using one threaded end at the elbow.

Make the bend by slipping this threaded end into a piece of larger-diameter pipe for a distance about 8″ shorter than the overall downward run into the trench. You can hold the larger pipe flat on the ground by parking a wheel of your car on it. Then bend the conduit upward a little at a time until you have a right-angle bend with about an 8″ radius. Hacksaw it to leave about a foot to rest on the trench bottom. Be sure to ream this cut end with a pipe reamer so burrs won't cut the cable insulation. If galvanized thinwall conduit is available in your area, it's a little easier to use. Avoid ungalvanized types; they corrode rapidly.

Trench and cable work. The National Code requires a minimum trench depth of 18″ where the cable lacks additional protection such as conduit or concrete slabs.

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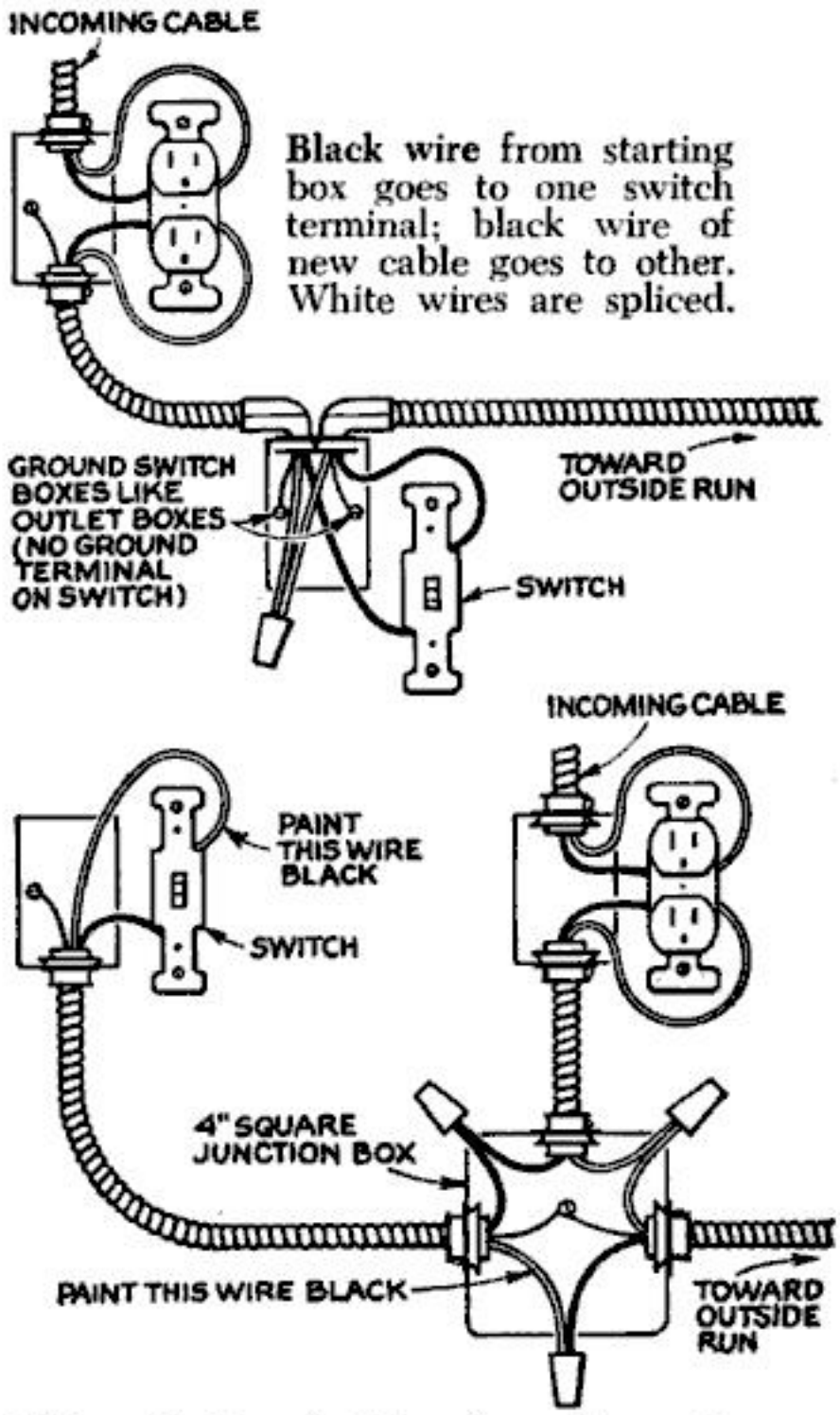
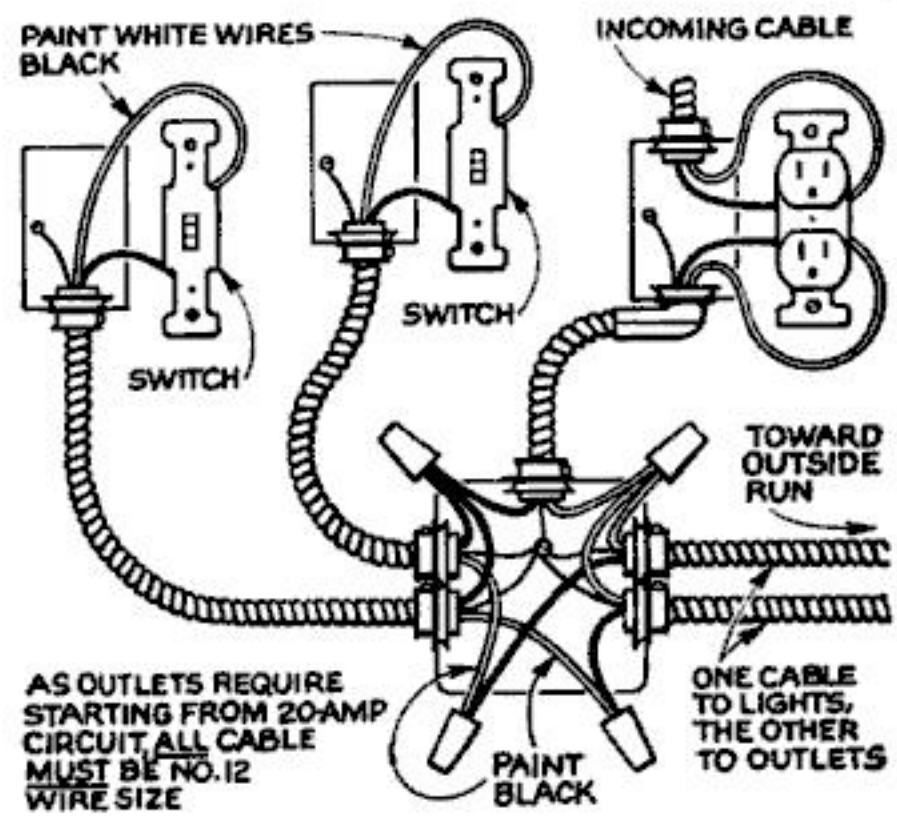
Three switching methods



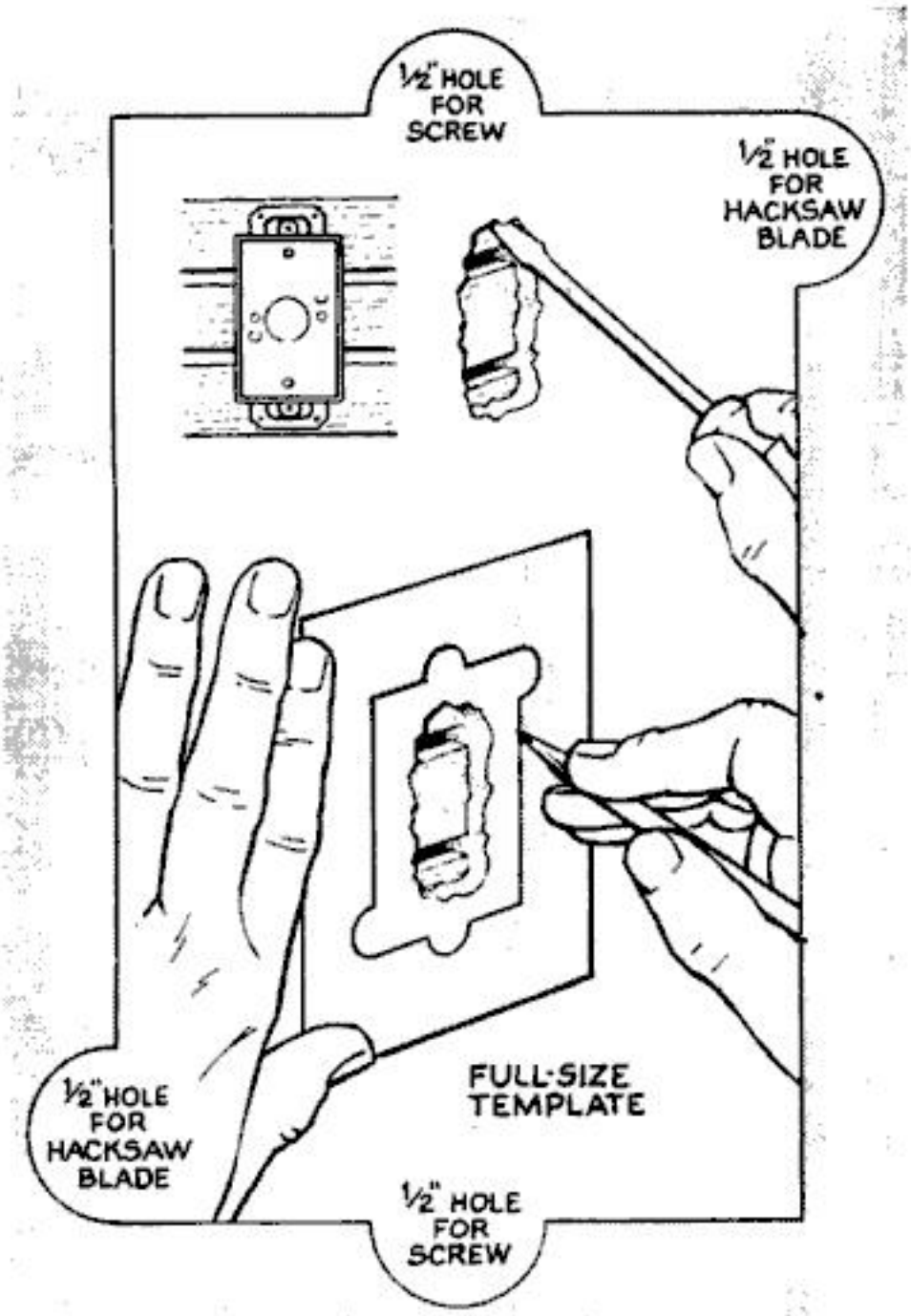
Where black and white wires of two-wire cable run to remote switch, paint white ends black. At box, white wire from outlet joins new-cable white wire. Black-painted one joins black wire in new cable.

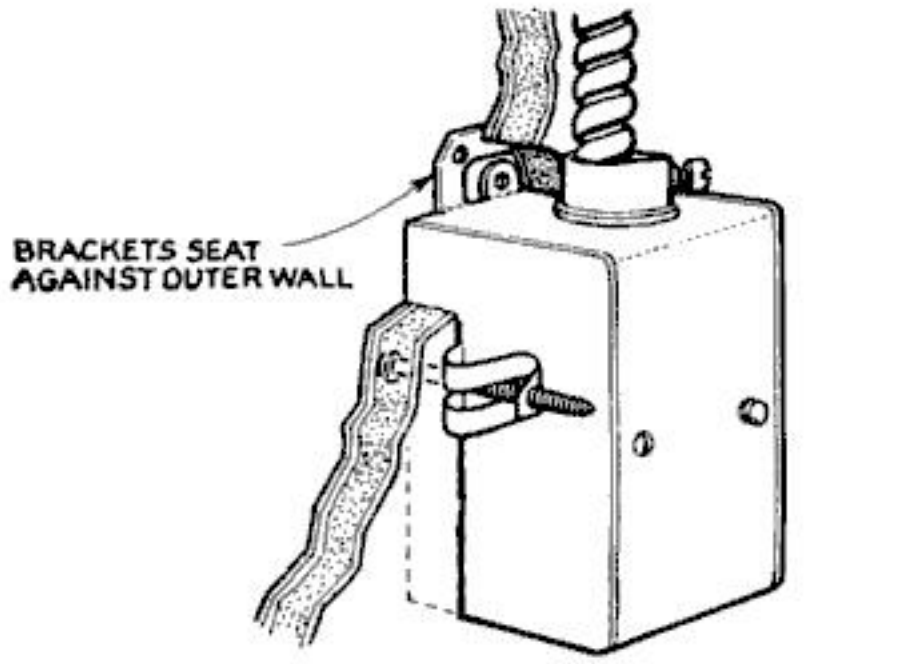
Black wire from outlet is spliced to both black wires leading to switches. Black-painted wires should be spliced to blacks of new cable runs. White wire from outlet joins both new white wires.

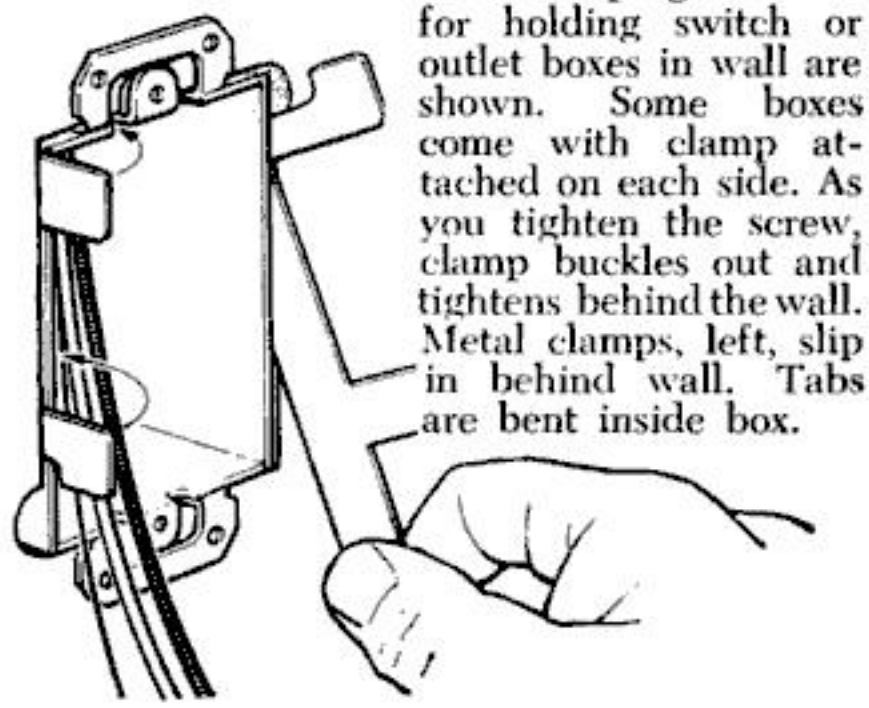

PAINT WHITE WIRES BLACK
INCOMING CABLE
SWITCH
SWITCH
TOWARD OUTSIDE RUN
AS OUTLETS REQUIRE STARTING FROM 20-AMP CIRCUIT, ALL CABLE MUST BE NO. 12 WIRE SIZE
PAINT BLACK
ONE CABLE TO LIGHTS, THE OTHER TO OUTLETS

new light fixtures

Urheberrechtlich geschütztes Material







Two clamping methods for holding switch or outlet boxes in wall are shown. Some boxes come with clamp attached on each side. As you tighten the screw, clamp buckles out and tightens behind the wall. Metal clamps, left, slip in behind wall. Tabs are bent inside box.

You can ease the job by digging to shovel-blade depth, then making a slot to full depth by inserting the blade vertically and tilting it. To keep your lawn shipshape, lift the sod off with the shovel before trenching, and lay it root-side-down so the roots won't dry out before you replace it.

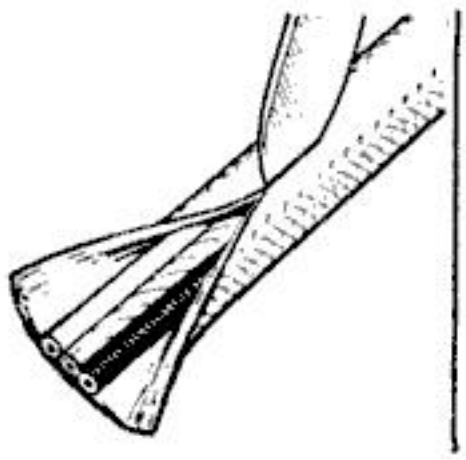
The easiest way to lay the cable is from post to house. The reason: The outdoor length is likely to be much greater than the indoor length, so you want to pull the shorter length through the wall or elbow to save work. If the post is set only to 18" depth, it's a good idea to embed it in concrete, leaving the cable clear in case it needs replacing. Another way: Set the post deeper than the trench depth and lead the cable through an oversize hole drilled in the post at trench depth.

Where the cable leaves the conduit underground, provide a waterproof seal around the cable with a compound made for the purpose.

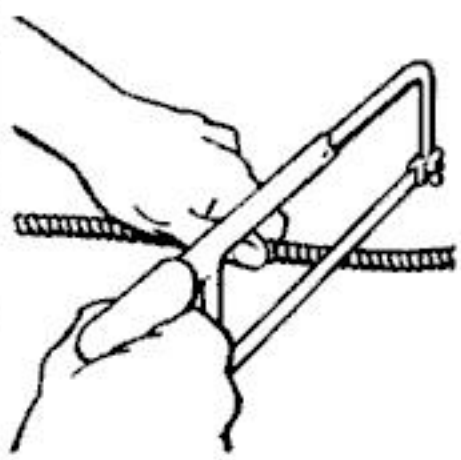
Inside, the cable runs to the switch, then the starting box. All connections are made according to these basic rules: At terminals, white wires go to chrome screws, black ones to brass. At wire-to-wire splices, (if you have to start from a junction box instead of an outlet box) wires are always spliced white-to-white, black-to-black. (The only exception is in remote switching, as shown in a drawing. Here you must use a white wire as a black one because you can't buy cable with two black wires. So you paint the white wire's visible ends black.)

Where the current-carrying cable leads to a switch, only the black wire is ever connected to the switch—and you'll note that the switch has only brass terminals.

Three simple ways

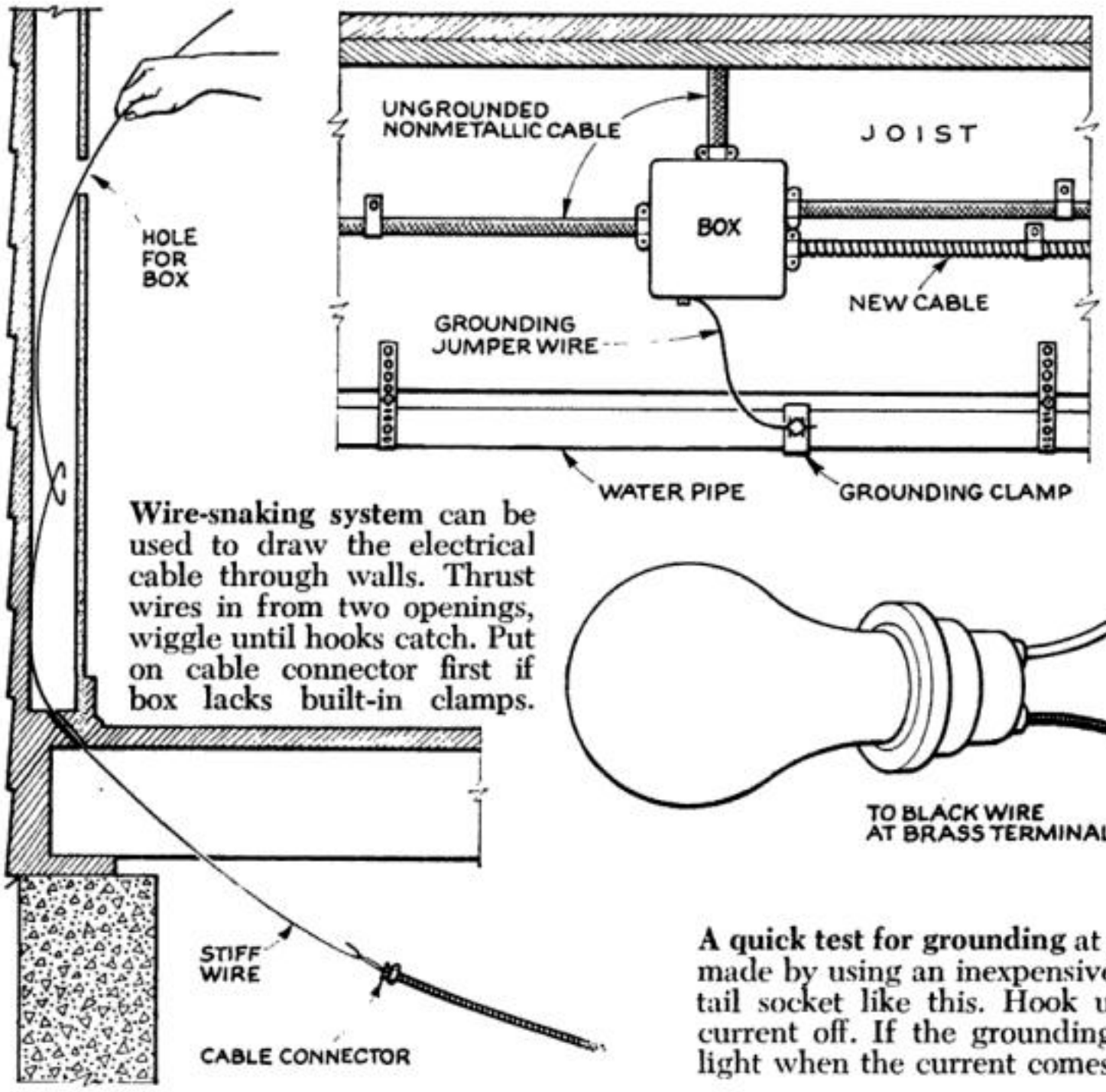


Free wires of nonmetallic cable by slitting covering with knife tip.



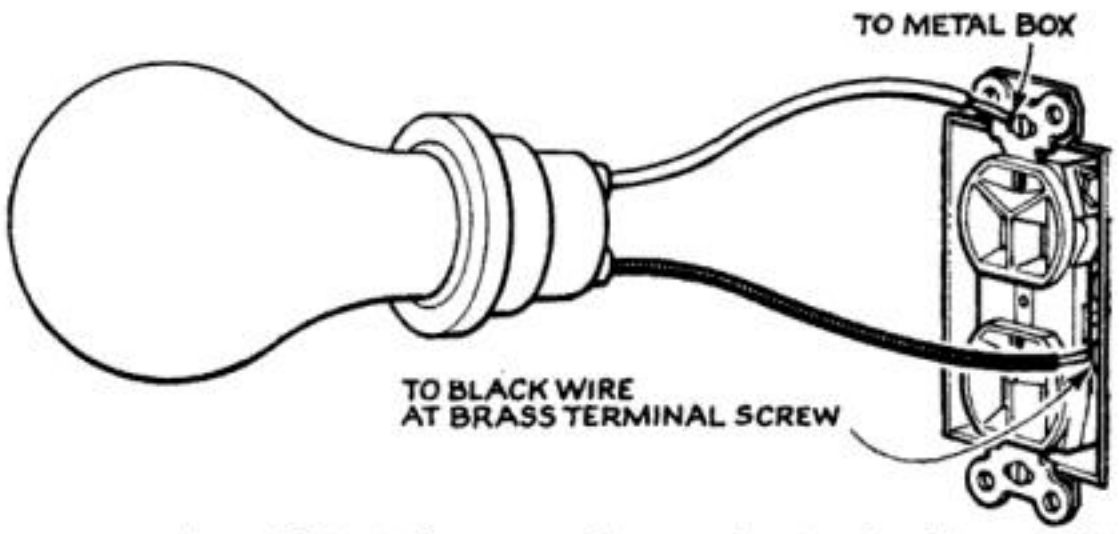
One way to cut armored cable: Saw diagonally, twist armor.

Urheberrecht ch geschützes Material



Code requires proper grounding at box from which you start new wiring. If replacing old ungrounded cable isn't feasible, grounding jumper wire to a water pipe is often approved. But better check local code first.

Wire-snaking system can be used to draw the electrical cable through walls. Thrust wires in from two openings, wiggle until hooks catch. Put on cable connector first if box lacks built-in clamps.



A quick test for grounding at the starting box can be made by using an inexpensive rubber-insulated pigtail socket like this. Hook up the tester with the current off. If the grounding is okay, bulb should light when the current comes on.

The "grounding" wire always connects to the metal box or to the metal shell of the fixture, as at a post lamp. These rules apply to all the other wiring jobs that follow.

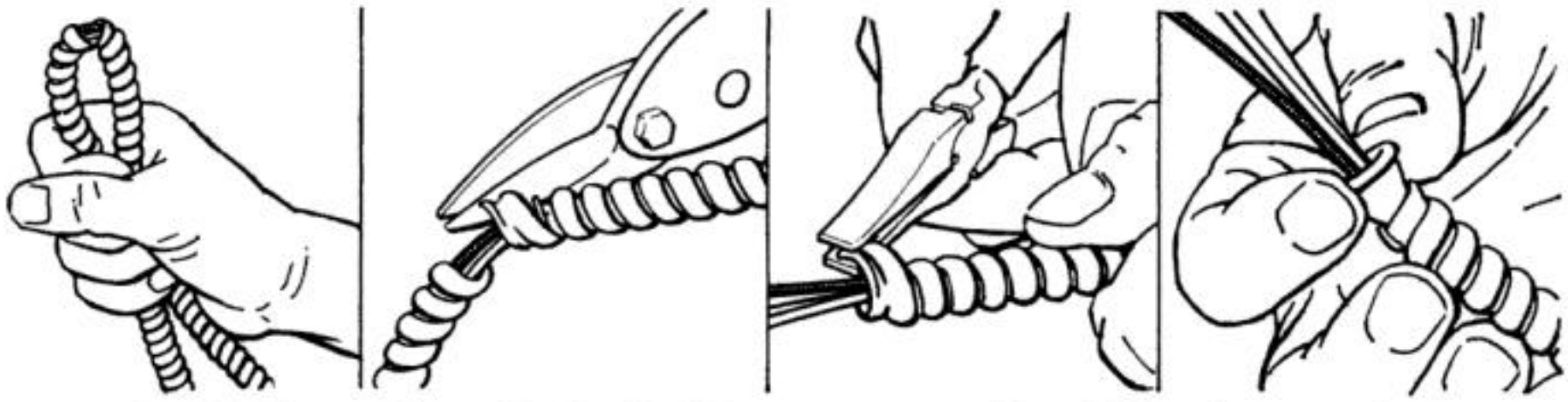
Outdoor floodlights. Wiring for these is basically the same as for a post light. If the flood is used to light an entrance walk, you can wire it to go on and off with the post light. Good floodlight locations are above the doors of an attached garage or under the eaves of the house. As the wiring is inside the house wall you don't need weatherproof cable.

If the wiring must start from the living area of the house, you can spot an end-of-the-run outlet box by shutting off the current and removing outlet covers until you find a receptacle with a pair of unused terminals. If the switch is to be in the same room, the easiest place to put it is directly over the starting box.

To lead the wiring from starting box to switch, first use the full-size template to cut the switch-box wall opening. Use a ½″ bit for the starting holes, a pistol grip

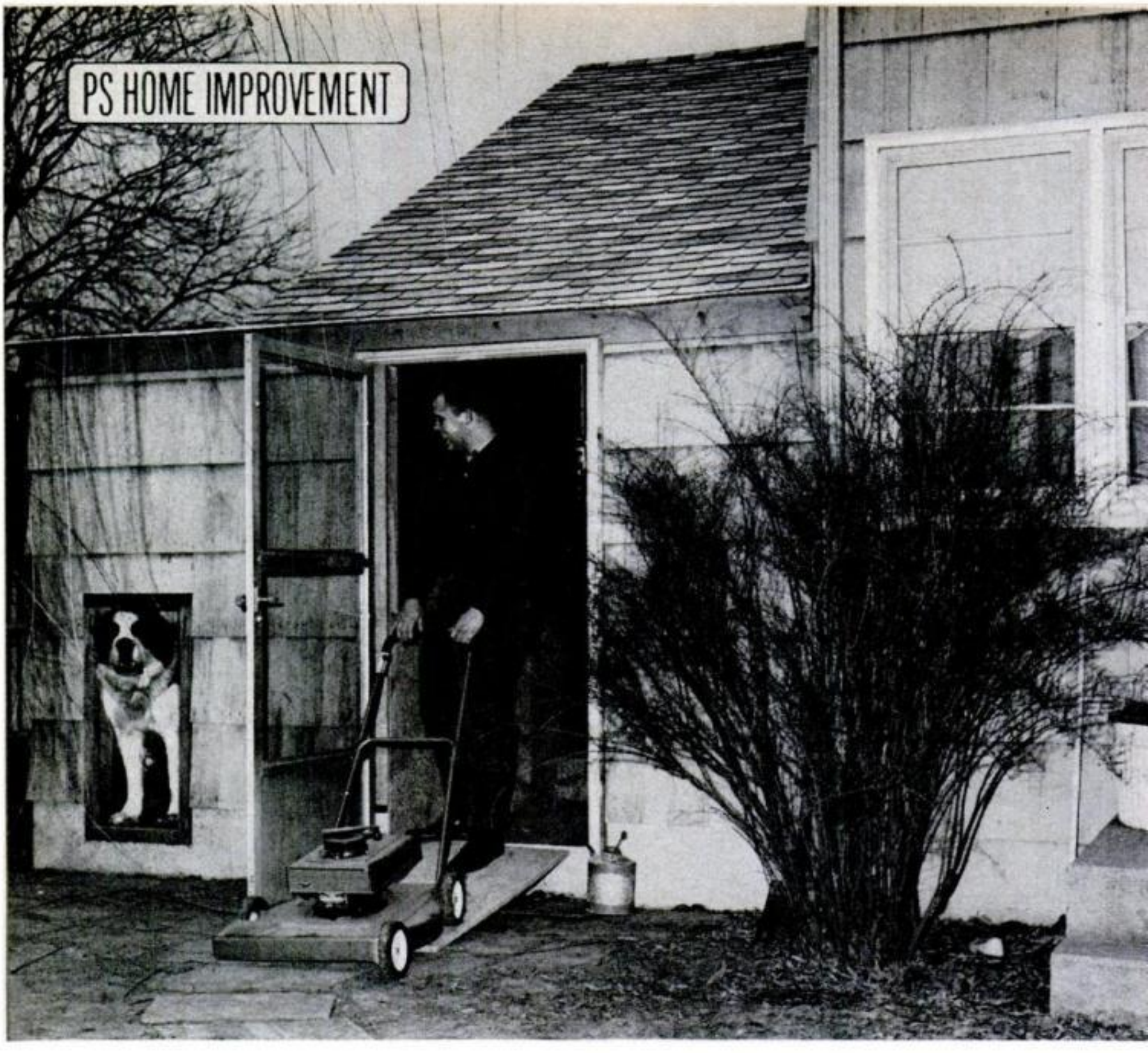
[*Continued on page 174*]

to cut electrical cable



Armored cable also can be cut by first buckling armor. Twist cable against spiral to lift armor. Then snip armor; slide it off if you're freeing wires at cable end. Use pliers to reshape snipped armor so it won't chafe wires. Finally, slip fiber bushing around wires and into armor.

Urheberrechtlich geschütztes Material



Tool Shed Houses

You can borrow many good ideas from the man who put up this structure to solve two problems

By Herb Pfister

"AS LONG as you're building a storage shed for the garden tools," my wife said firmly, "let's store Bruno, too. A 175-pound Saint Bernard doesn't belong in the house."

So I revised my plan and drew new sketches for the structure. Half of the 6′-by-12′ shed would be for garden tools, the other half for Bruno.

The way I built my shed, it fills in a corner between the house and the garage. You might prefer it added to a straight wall —or even as a free-standing structure.

To keep costs down (the job ran to about $1.35 a square foot) I carefully removed the shingles from the rear of the garage and the side of the house, for re-use on the new walls. I set 6″-by-6″ cedar posts in the ground, well below the frost line to provide a stable footing. To keep the floor low, I nailed plywood hangers to the back of two-by-four stringers, and nailed the plywood to

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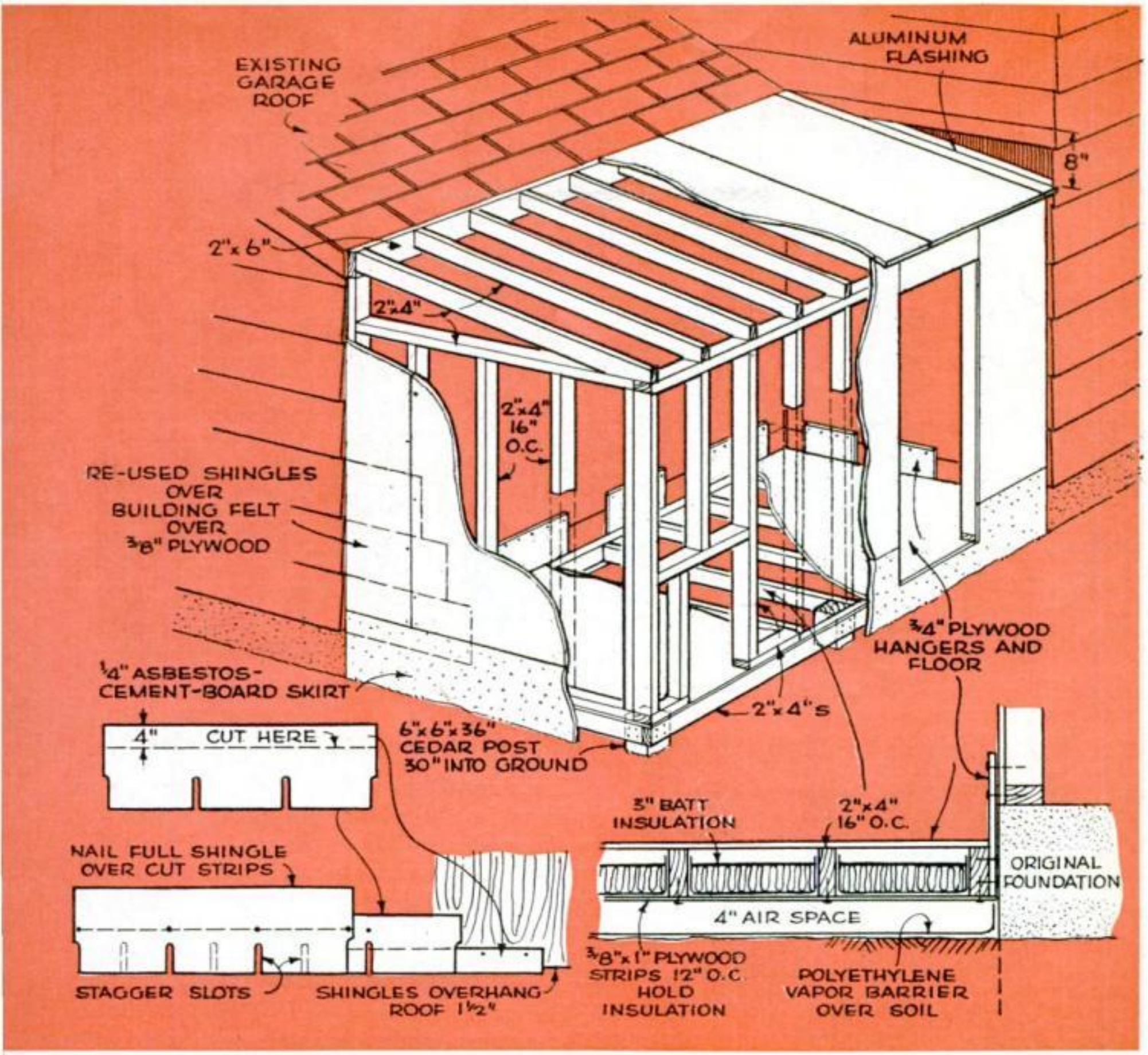
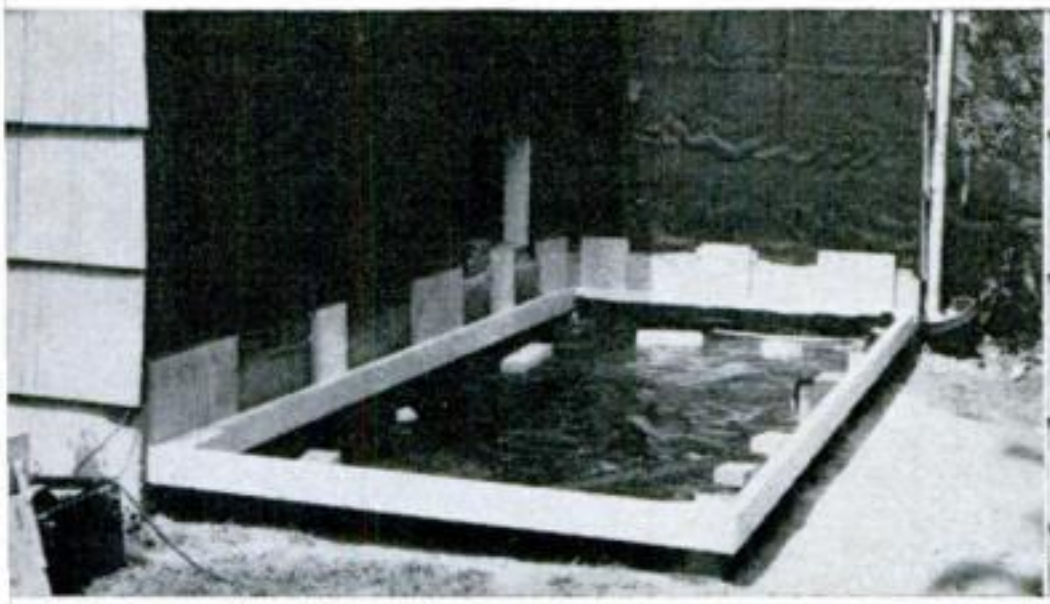
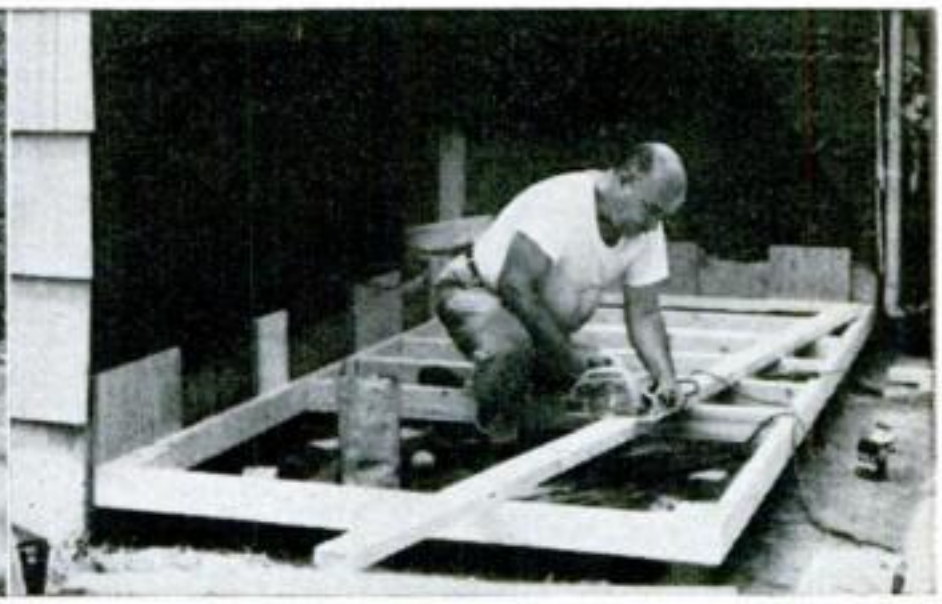
Urheberrechtlich geschütztes Material



the Dog, Too



Polyethylene film on the ground, upturned at existing walls, cuts down danger of rot. Floor is high enough for air circulation. Use wood preservative on post, set below frost line.



Keep the floor line thin and conserve storage space by setting the joists between stringers, not on top of them. Key to maximum strength here is carefully fitted square-cut joists.

Urheberrechtlich geschütztes Material

New roof line takes off just below the sheathing of old roof. New roofing slips beneath the old, for a watertight joint. If the old roof is higher, take off from the wall below the eave line.

Using salvaged shingles saved money on this project. If you do the same, you can speed up the shingling job by tacking up a straightedge as a guide to keep the shingles even and level.

the house framing so that the top edge of the headers was 8″ above grade. Then I leveled the two outside headers and nailed them to the cedar posts to complete the perimeter framing.

Before nailing in the floor joists, I covered the ground beneath the shed with a sheet of polyethylene film to keep dampness down. Then I installed batt insulation between the joists, and put down a ¾″ plywood floor.

The short 6′ span allowed the use of two-by-fours for the rafters, toenailed to a two-by-six header spiked to the wall. Since the existing roof was low at that point, I held the rafters just below it, so the sheathing would line up. If the roof had been slightly higher, it would have been simpler to bring the shed into the wall under the eave line.

The walls and roof were closed in with ⅜″ sheathing-grade plywood, over which I stapled asphalt-saturated building felt.

To continue the foundation line, I nailed on an 18″ side skirt of ¼″ asbestos-cement board around the base of the addition.

Using a taut, leveled string as a guide to maintain alignment with existing shingles, I nailed up those removed earlier. Since they match the other shingles, the addition appears to be part of the original house.

Two bundles of mineral-coated roof shingles the same color as the existing roof covered the shed. I slid the last course of new shingles under the eave shingles on the garage to provide a continuous overlap for rain runoff.

I hung an old aluminum storm door in the doorway of the storage area, but an inexpensive and decorative door can be made by nailing one-by-four pine strips in a Z or crossbuck pattern over a panel of ¾″ exterior plywood. ■ ■

Urheberrechtlich geschütztes Material

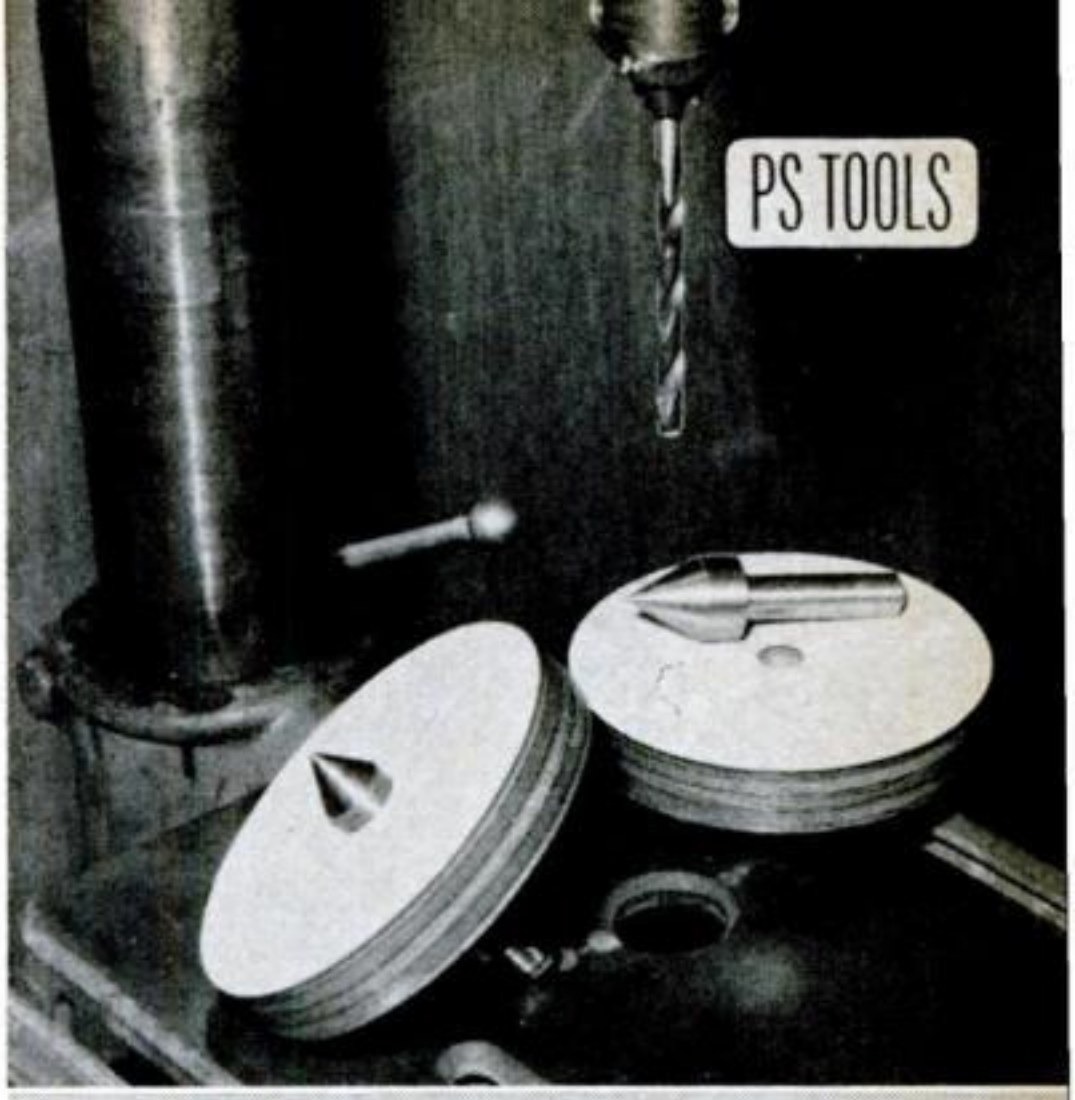
Work-Holding Center for a Drill Press

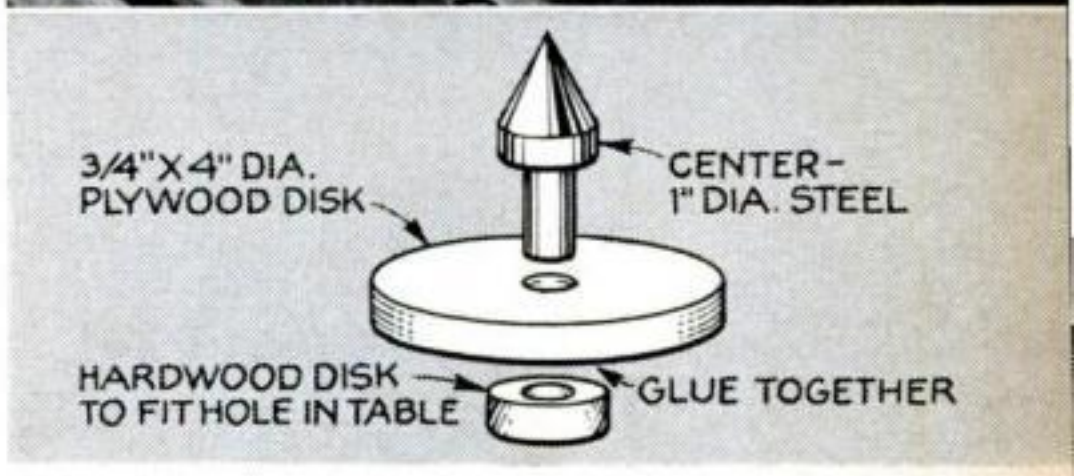
Tough jobs become a lot easier with this simple device. Here's how to make and use it

A CENTER like this one makes a drill press an even handier tool. If a bit is too short to go through a handle for a file or screwdriver, set the handle on the center, drill one end, change ends and drill the other. The holes will meet—the drill can go only toward the center. Thus you get an 8" hole with a 4" bit.

Irregular shapes are also easily drilled through this way. Angle drilling that normally requires tilting of the drill-press table plus a mass of clamps is a cinch. Lamp uprights can be drilled for the cord. First you set the base on the center and drill each end. Then you chuck an extension of the *same diameter* in an electric drill and finish the job. The holes made on the drill press provide a bearing for the extension, and the holes must meet.

To make the holder for the center, cut out the two disks and glue them together. Then, with the small disks pressed into the hole in the drill-press table, drill directly through with the proper size drill to take your center. In this way you tailor the unit to the machine you are going to use it on.—*William G. Waggoner, Sacramento.*



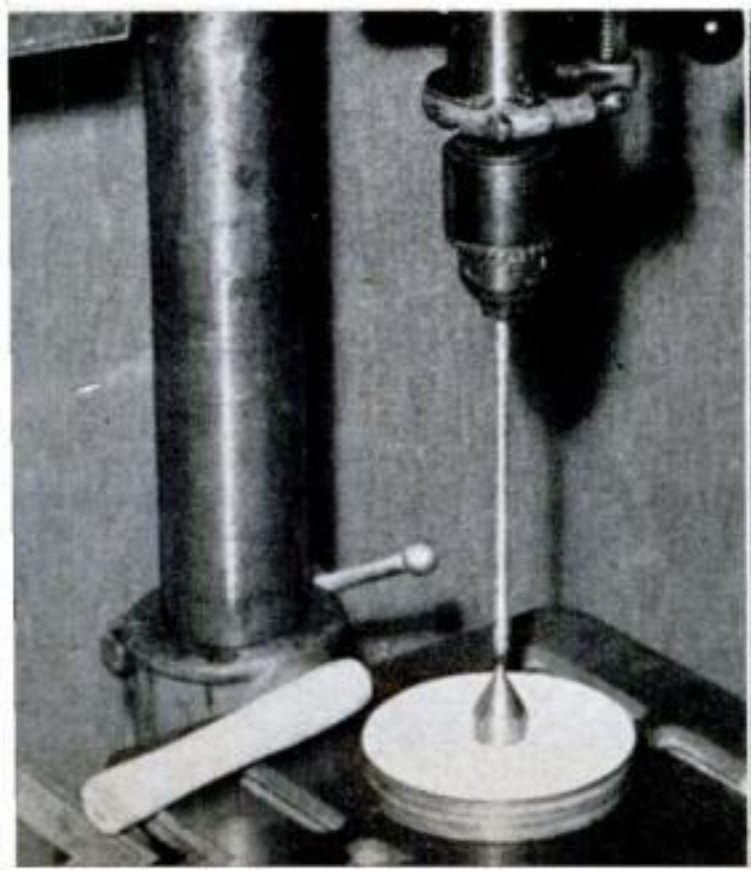


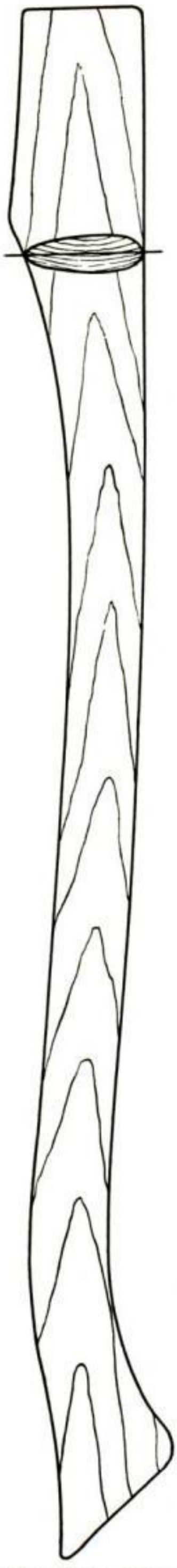
Borrow a center from another tool or machine your own from about 1" rod. The latter size will permit you to drill holes up to ⅞".

Set up the center by chucking a straight, pointed rod in the drill press. Line up the two points, lock the table in place, and insert drill you want to use.

To use the center, you set the work on its point (round work is centered, of course), grasp the work firmly as below to keep it from turning, and feed the drill.

One hand holds the work—no matter how irregular its shape. Angle drilling is easy, too, when you have the center in your store of accessories.





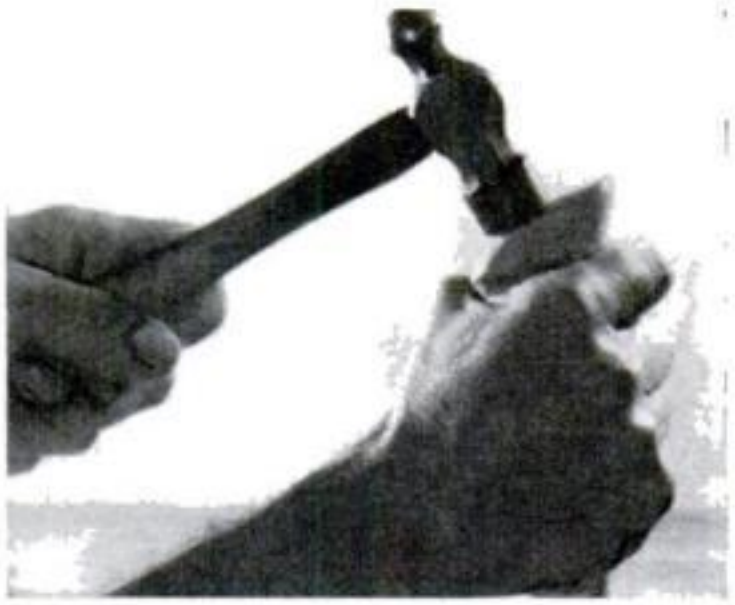
How to Hang an Axe

IF YOU own an axe and use it much, sooner or later it will need a new handle. It may break—or it may just wear out as the result of many near-misses. When a handle begins to get chewed up near the head, replace it. Otherwise, it will break at some inconvenient time. (If you don't own an axe, this applies equally to hatchets, hammers, sledges, etc.)

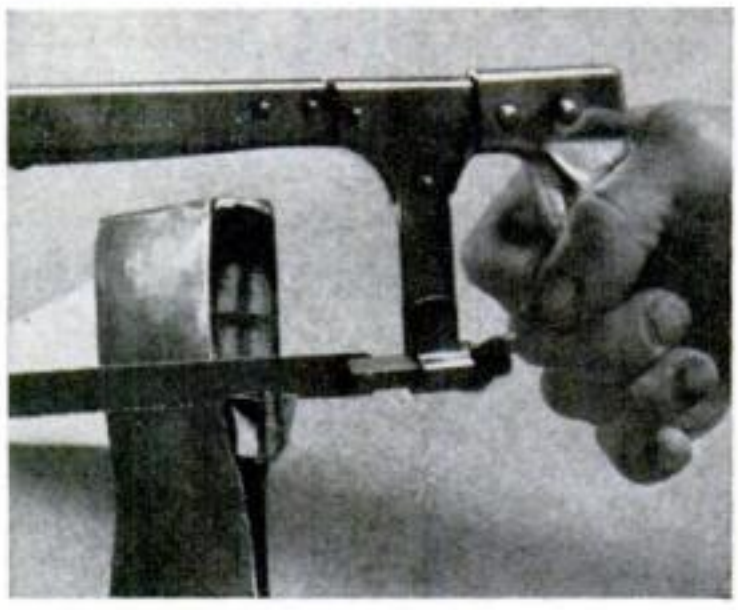
Pick a handle worth the trouble. Go through the dealer's stock until you find one with the *edge* of the grain on the top and the bottom, the *flat* of the grain on the sides, as the sketch at left shows. Don't accept one with grain that angles across from one side to the other. Ideally, the edge grain should run the full length.

Don't buy any handle that is not hickory. Beware of handles that are painted—the paint may cover up defects in the grain. Many handles are much too big for the eye of the axe and take a lot of dressing. You avoid this if you can find a handle made by the company that made the axe.

1 Dress handle to size with a wood rasp, working on alternate sides to keep it straight and symmetrical. Avoid a sharp decrease in size—it encourages breaking. While head is off, grind the edges smooth and sharpen it.



2 Try it for size frequently, to avoid taking off too much wood. Don't strike point of single-bit handle—hit it as shown here so head is pulled on. Finally, head should go on to about ½" from the widest point.



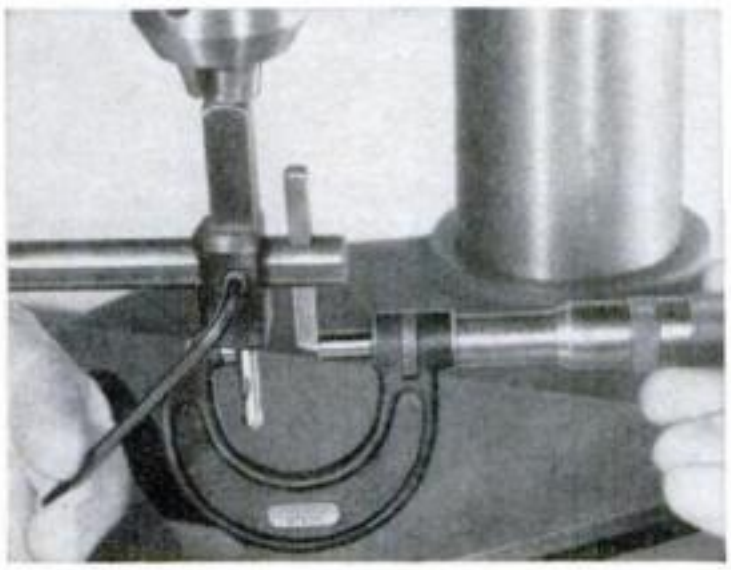
3 Cut off the excess after you have driven the wedges. Use a hacksaw, which won't be ruined. Wedges should be in the form of a cross, to tighten handle both ways. If necessary, make saw cuts to get wedges started.

4 Brushing on wood preservative or sealer is a good idea, but never paint the handle of an axe. Some stores sell a dope for the end that swells handle and wedges for tighter grip and keeps them from drying out.

Urheberrechtlich geschütztes Material

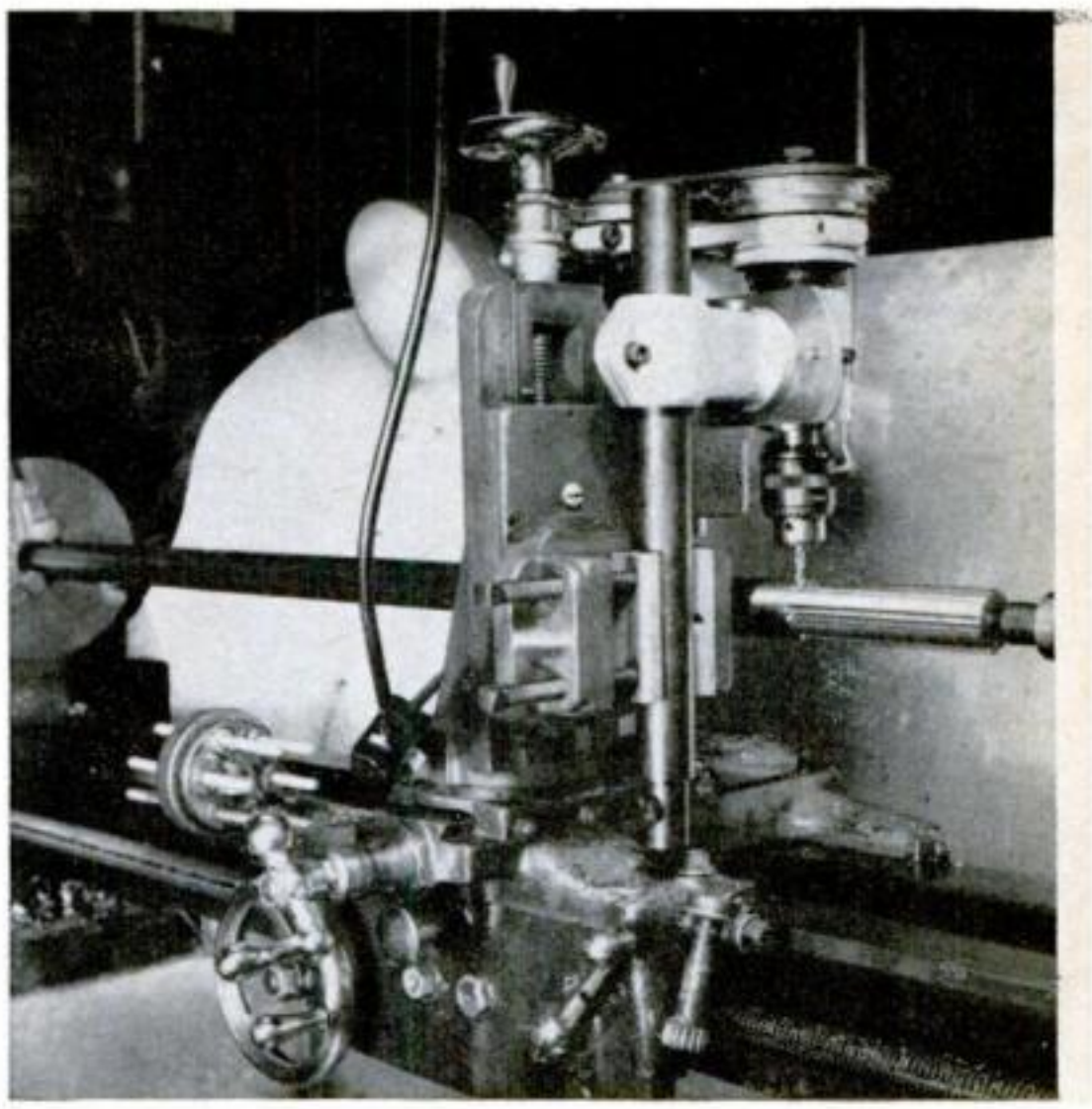
PS METALWORKING

Short Cuts for Machinists



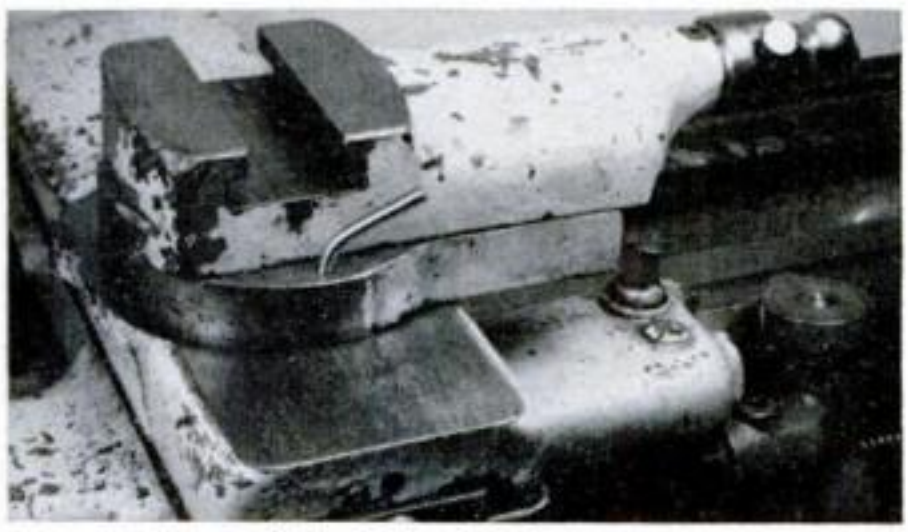
Adjusting a fly cutter

I adjust a fly cutter accurately in a single setting with the aid of a bit of arithmetic. I take the radius of the pilot drill and add it to the radius of the hole that is to be cut. This is the setting for my caliper or micrometer. Placing the anvil of the micrometer on the pilot drill, I move the fly cutter out until it touches the spindle.—*Casmer R. Dombrowski, Detroit.*



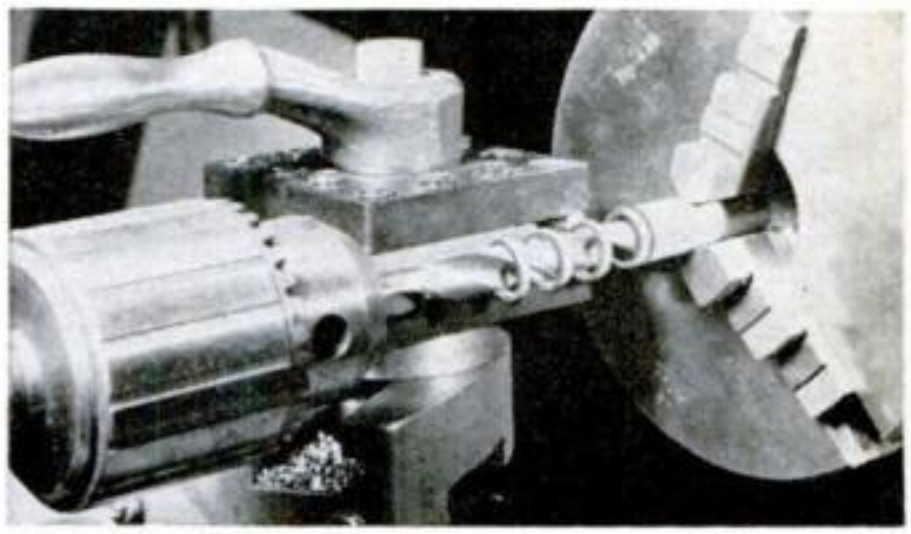
Machining a straight spline with a lathe

Sometimes the task of splining a shaft comes up during a repair. Instead of sending out the job, use this setup to mill the splines on a lathe. After turning the spline end of the shaft to the proper diameter, set up the power head in the milling vise of the lathe as shown. Using the indexing device built into the lathe spindle, locate the position of each spline. The cross-feed dial on the lathe provides a means of finding and repeating the width of each cut, while the milling vise is used to bring the cutter to right depth.—*Jack Payne, Franklin Lakes, N.J.*



Quick indexing of lathe compound

Fast, precise setting of a lathe compound at often-used positions is easy. Remove compound from the lathe and drill through the lip of the base. Replace on cross slide and set at a frequently used position. Using hole in compound as a guide, drill down into the cross slide. Ream for taper pin, and insert pin. Bend the pin over to form a handle.—*H. J. Gerber, Menomonie, Wis.*



How to keep from losing small cutoffs

Small cutoffs made on a lathe have a habit of vanishing into the chip tray or elsewhere as they drop. If the stock has a hole in it, here is a simple way to avoid losing cutoffs. Chuck a drill or a rod slightly smaller than the bore in the stock and run it past the point of the last cut to be made. Parted pieces will line up on the rod.—*S. L. Walton, White Plains, N.Y.*

Urheberrechtlich geschütztes Material

Shotshells fired through a special smoothbore .22 pattern better than when fired in a .22 rifle.

Safe Trapshooting

Here's low-cost fun for the whole family that also develops the shooting eye

By Marv Lindberg

YOU don't have to belong to the skeet club these days to have fun shooting clay pigeons. Now you can set up any place a hundred yards long and bang away in perfect safety.

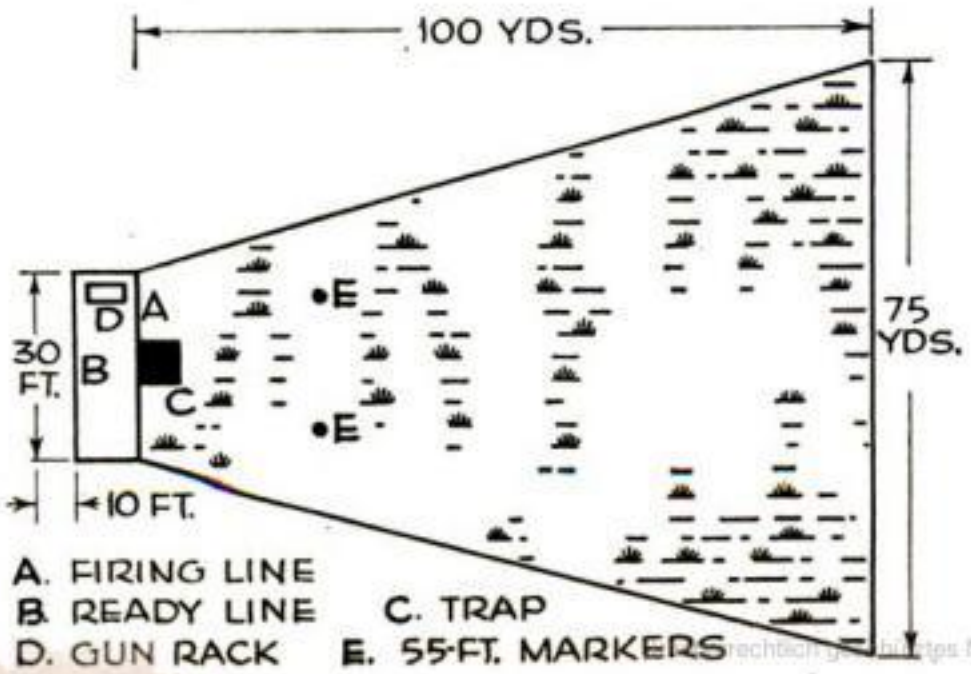
With a shotgun? Yes—but not with a .410 or even a 12- or 20-gauge. You can now buy .22-caliber smoothbore guns. They pattern well with the .22 shotshells which have long been available. You can also get small-size clay pigeons and a trap to throw them.

Everything is scaled down but the fun. A .22 shotshell is about two cents compared with 12 to 15 cents each for regular skeet shells. The little clay birds cost less, too, putting the sport well within limits for everyone.

Finding a shooting field, even in a built-up area, is comparatively easy, because of the low noise level of the .22. And the .22 is safe—the tiny pellets lose velocity

Special equipment for .22 skeet shooting is neither bulky nor expensive. Depending on the price of the gun you chose, you should be in business for as little as $50 to $75.

A safe range can be laid out in an area only 10[illegible] yards long by 75 yards wide (about football-field size). The tiny shot will all drop harmlessly within this area if you miss.



A .22 shotshell holds about 164 tiny pellets.

with a .22

and teaches safe gun habits

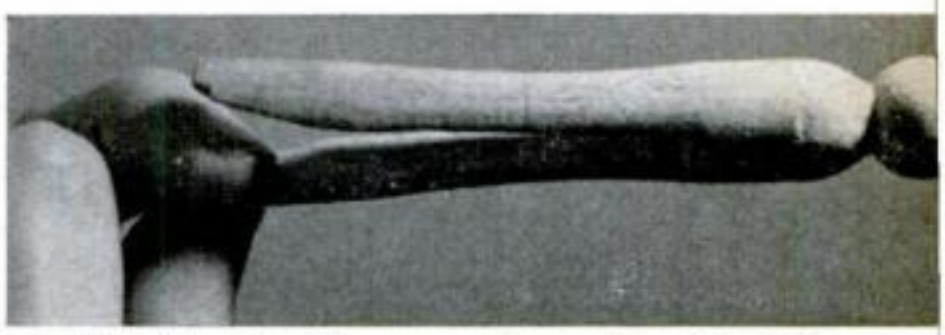
quickly and drop harmlessly. Falling shot can't break a window or damage property. Unless it were to hit bare flesh, you probably wouldn't even notice being hit by it.

Besides providing safe and inexpensive shooting, the .22 shotgun firing at special, junior-size clay pigeons is great for developing accurate wing shooting. You are trying to hit a smaller target with a smaller cluster of shot. Get good enough to do it consistently, and the larger target becomes a snap to hit with the larger shot pattern of a full-size shotgun. Equally important, the light recoil of the .22 won't make young shooters flinch as they might with even a .410 or 20-gauge. Once learned, flinching is harder to cure than smoking.

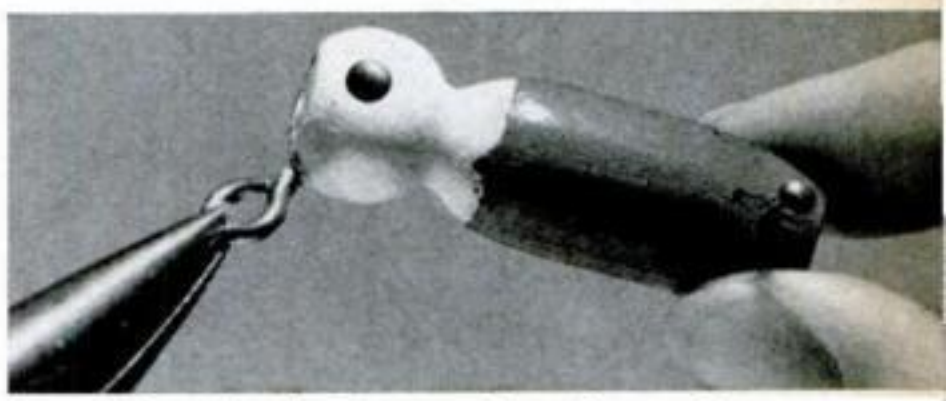
Shooting with the small-size equipment, you'll find it best to set your trap to throw clay pigeons about 50 feet at an upward angle of about 30 degrees.

You can buy a smoothbore single-shot or pump .22 made by Remington at any good sporting-goods store. The small-size clay pigeons and the trap are available from Bob White Target Co., 2101 Harrison, Kansas City, Mo., who also sell a smoothbore .22.

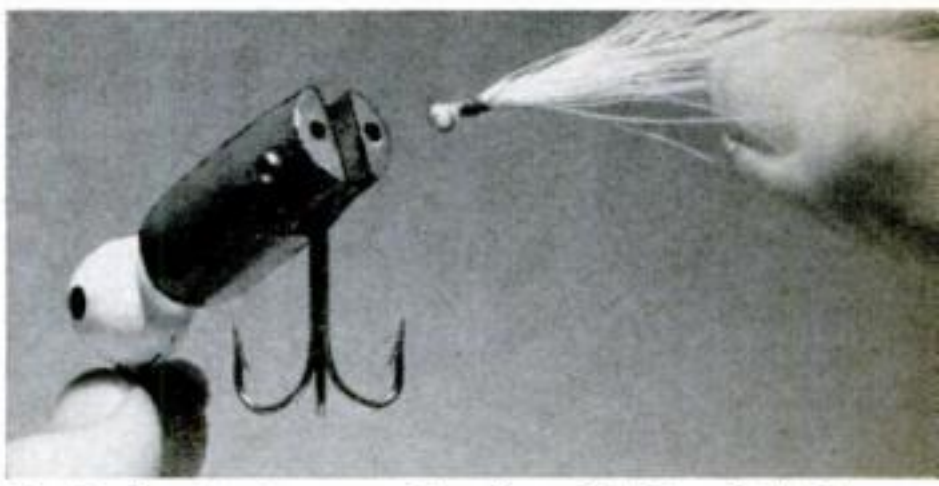
Make a Bass Plug from a Clothespin



Clothespin plug is a snap to make. Start by marking legs of the pin so you can saw them off to a length of approximately 2".

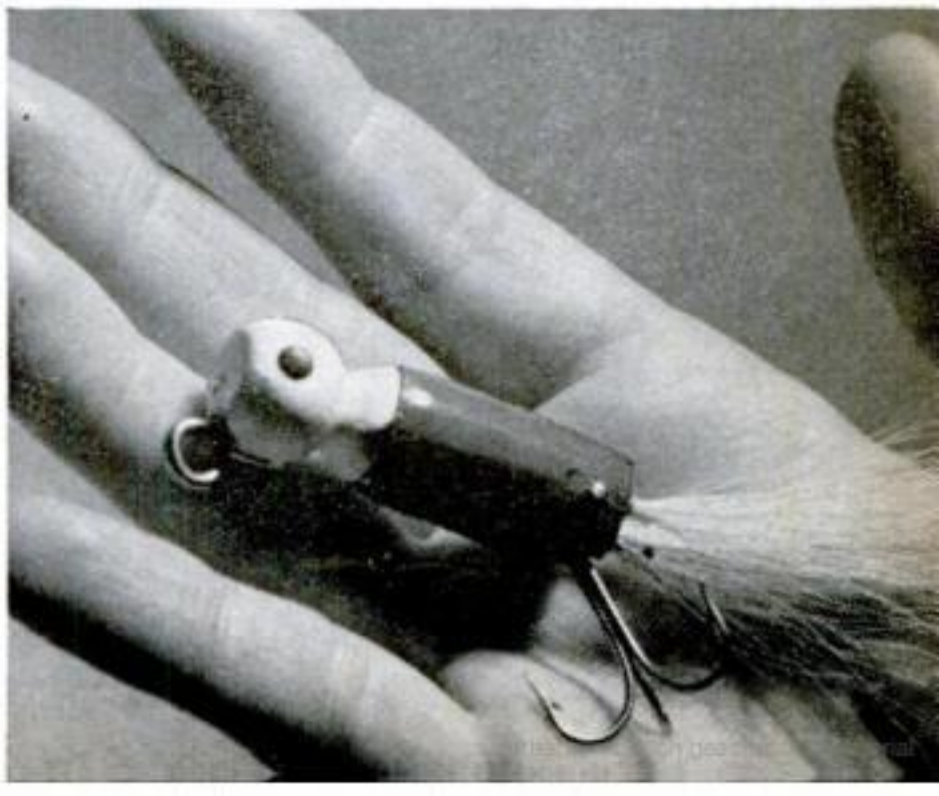


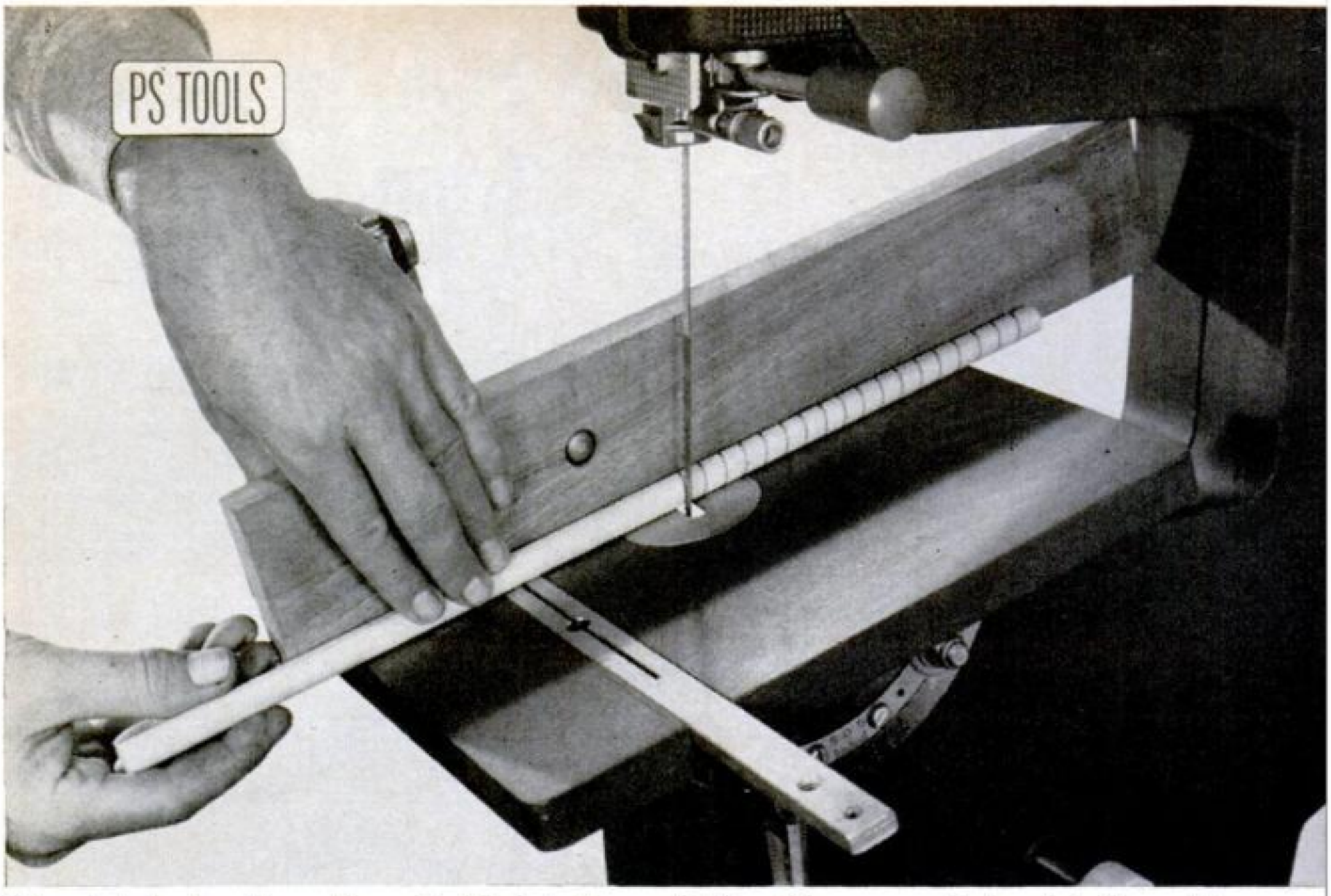
Paint plug by dipping in fast-drying lacquer of the colors favored in your area. Insert screw-eye for leader after painting.



Treble hook pivots on brad, and holes drilled in leg ends hold feathers. Use good waterproof glue to secure the feathers.

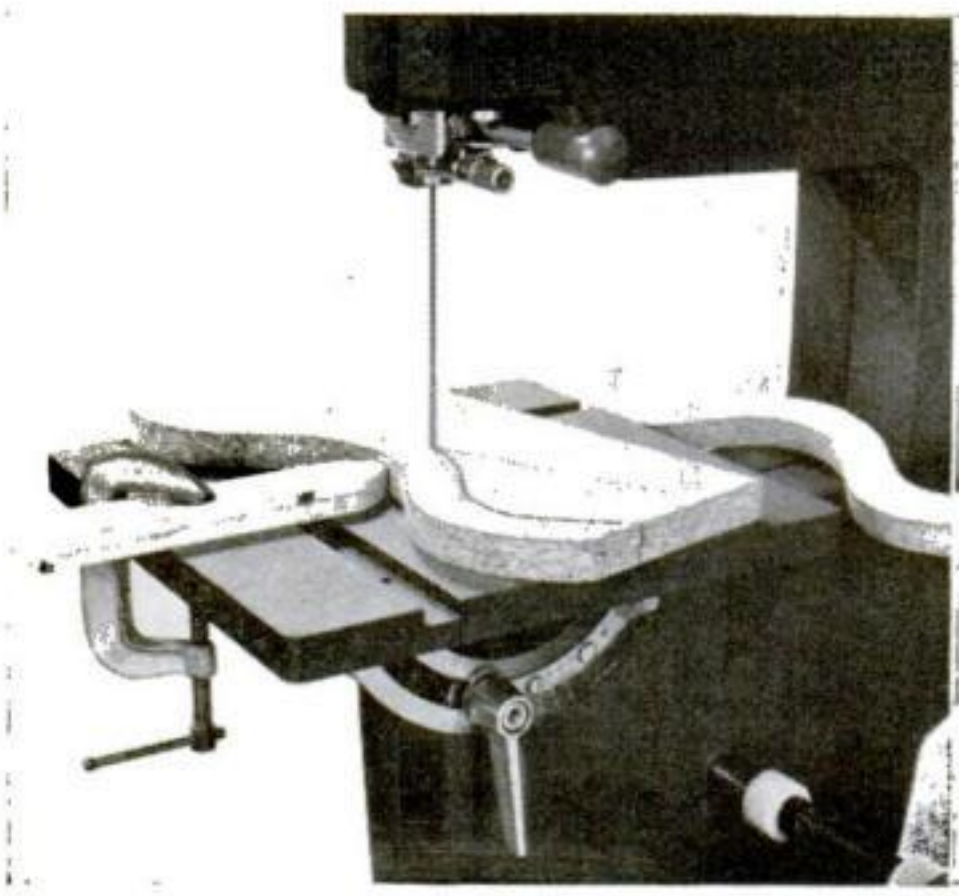
Finished plug costs next to nothing to make and really catches fish. Make several to try different color schemes.—*Don Shiner.*



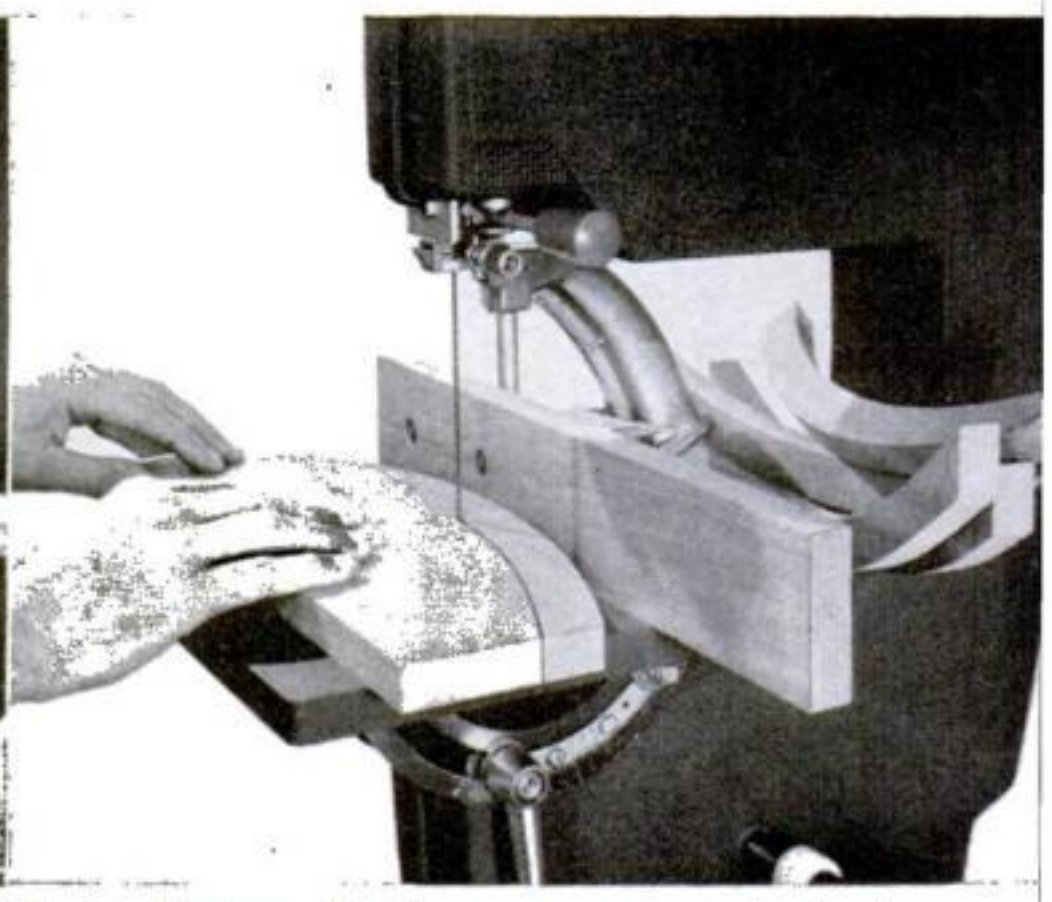


Cut spirals in dowels or other cylindrical stock by tilting the table slightly and placing the round against a fence. Adjust pitch of the spiral by the degree of table tilt. This operation is useful in cutting grooves in dowels to be used in construction, or as the beginning of a "rope-turned" spindle which you complete with the help of carving tools and sandpaper.

5 Tricks with a

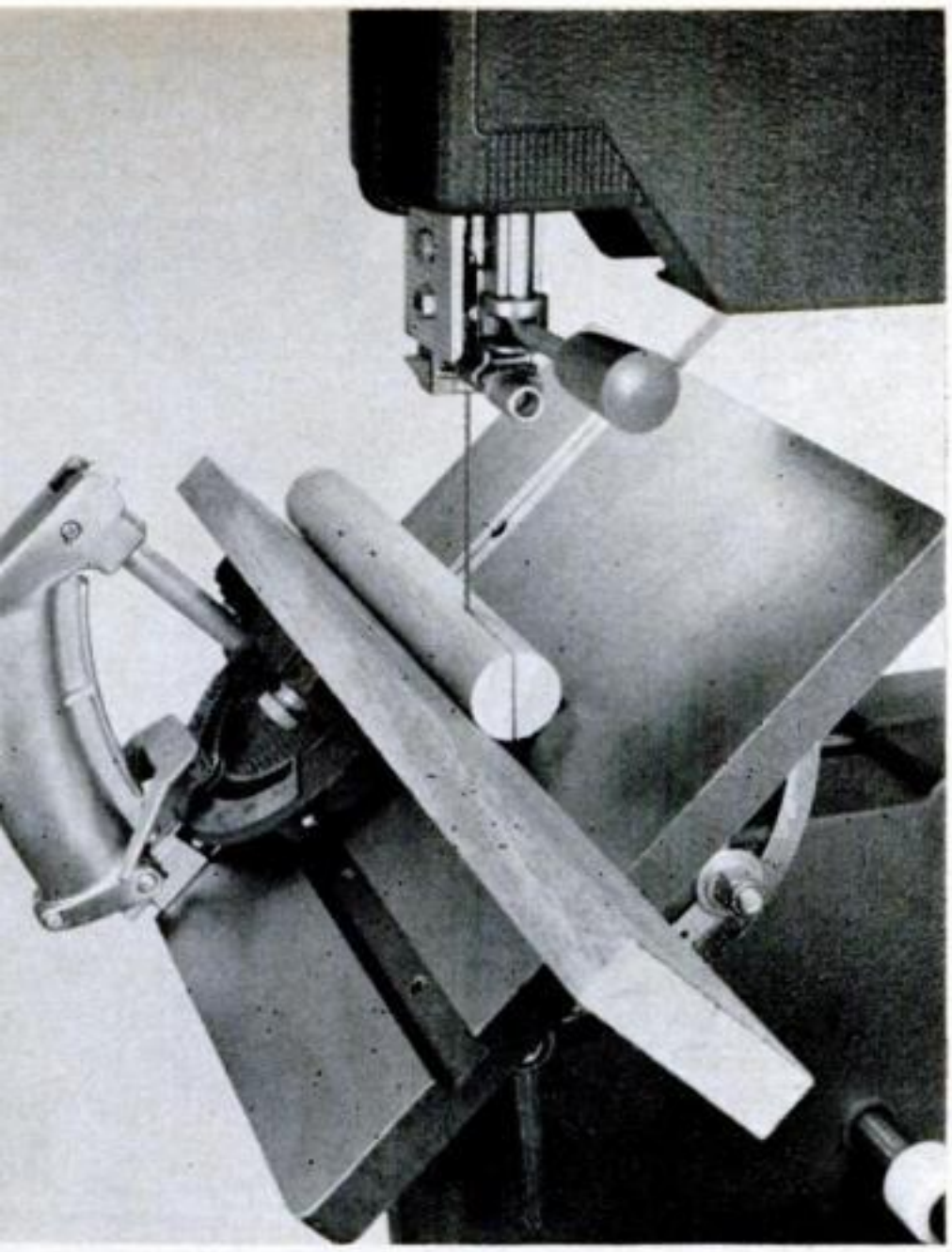


Duplicate any complex curve on a bandsaw by clamping a pointed stick to the table precisely opposite tooth edge of the saw blade, as illustrated above. Put the point at a distance equal to the desired width of the curved stock.



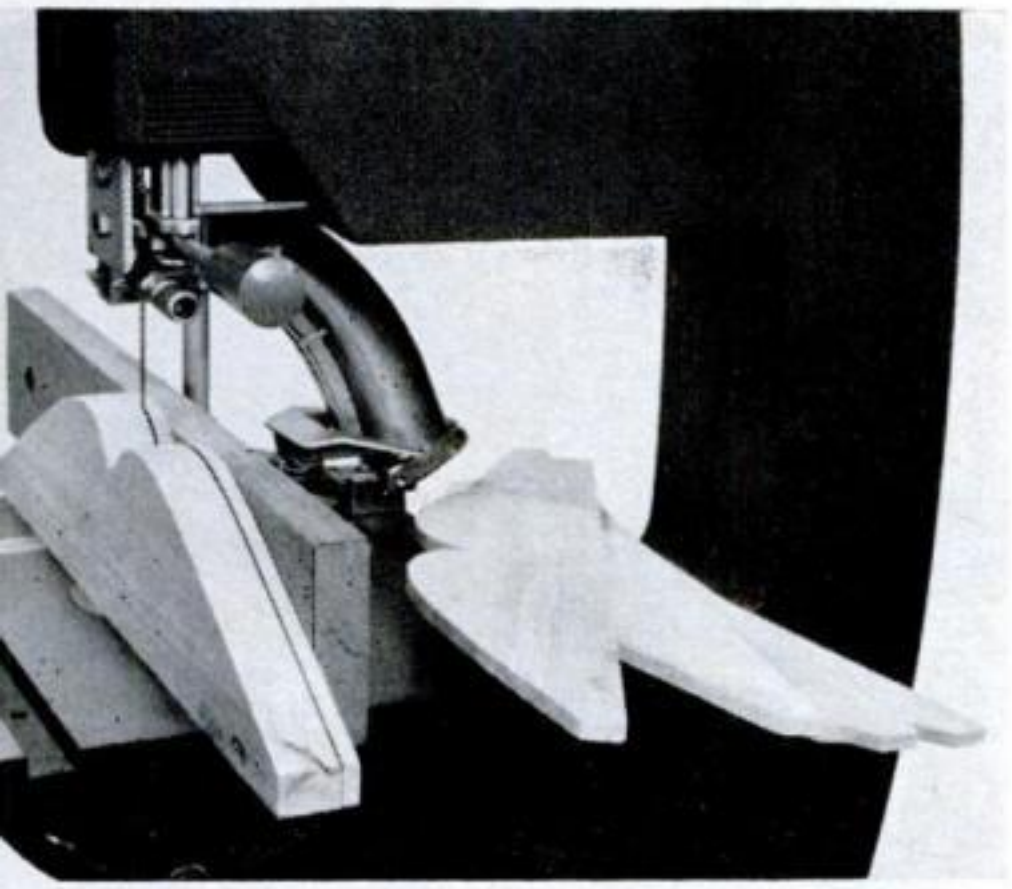
To duplicate a simple curve, you need only to lock a fence in position, as shown here. Make the first cut freehand, then keep the curve tangent to the fence for subsequent passes. Use a narrow blade to handle the curve easily.

Urheberrechtlich geschütztes Material



To slice a cylinder lengthwise, first tilt the table to 45 degrees. Then position the fence to control the amount sliced off. Use this trick also to cut triangular stock out of square stock.

Bandsaw

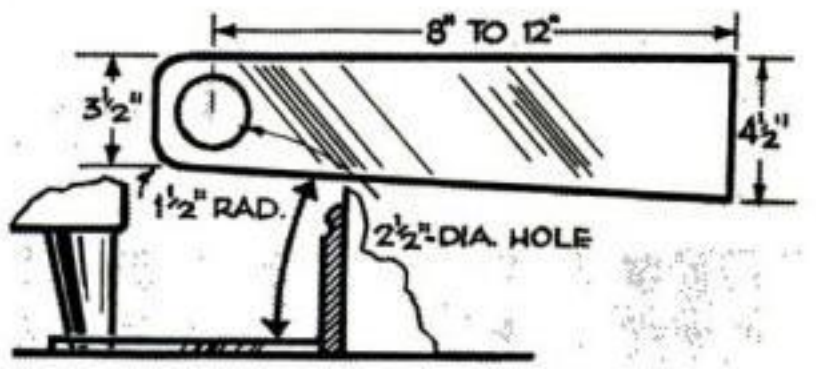


Duplicating a complicated form is easy by using the resaw technique, as demonstrated in the photo above. Cut the shape in heavy stock, then slice as many pieces as you need. Don't feed tool hard when you're cutting thick wood.

Dry lubricant for workshop use

Canning wax is a handy lubricant for many purposes around the shop. Use it on miter-gauge slots, tool-table surfaces, hand- and power-saw blades, etc. This "dry" lubricant will work where oil might stain the work.—*R. J. DeCristoforo.*

►►► Every home needs a hard-to-reach place where you can safely keep potentially dangerous things such as lye, drain cleaner, pills. I have found such a place on the wall in a basement stairway. A cabinet high enough so adults can barely reach it is surely out of reach of children. The steps leading to the basement keep them from pulling up a chair, as they would to raid the cookie jar.—*George A. Mayerchak, Bellevue, Neb.*



Plastic makes invisible furniture stop

A set of clear plastic stops shaped as in the drawing above will keep a sofa or chair from sliding back against the wall. Dimensions are not critical except for the length, which you should measure with the furniture in place. Cut the shape with woodworking tools; polish the edges. —*Jack Peretti, Cheyenne, Wyo.*

Urheberrechtlich geschütztes Material

SAILBOARDING: Exciting New

For high-speed water fun, nothing can touch a sailboard—it's a sailer, aquaplane, or swim float

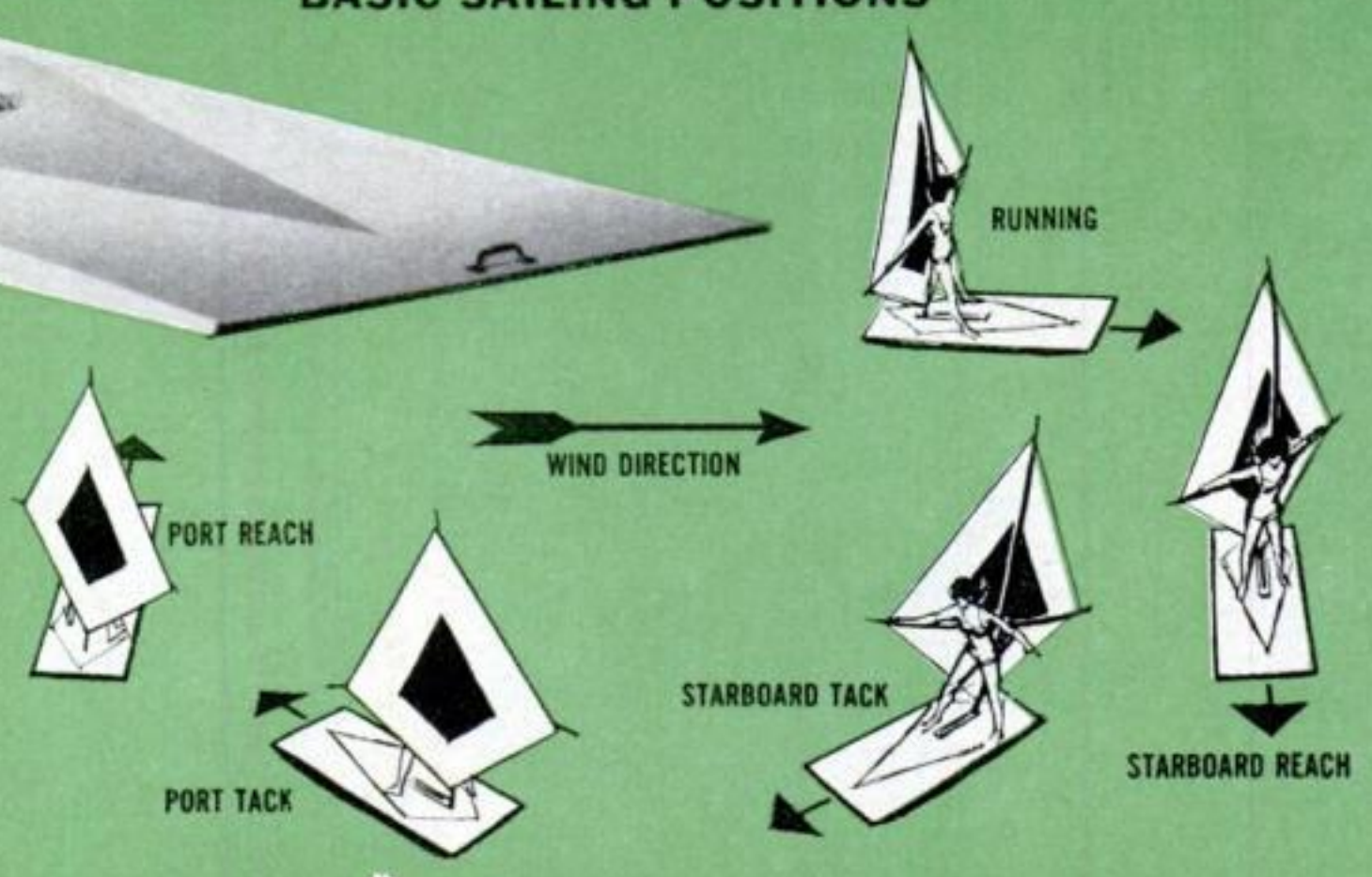
By S. Newman Darby

A SPORT so new that fewer than 10 people have yet mastered it promises to become inexpensive sailing fun for many who love to sail, but don't want to have to live with the expense of keeping a full-size boat. Sailboarding is sailing with a difference. You get all the fun of handling a fast, responsive boat. You can have the fun of spills without the work of righting and bailing out. And you can learn to master a type of maneuvering that's been dead since the age of the picturesque square riggers.

You'll find the sailboard versatile: You can use it as an aquaplane behind an outboard as well as sail it. You can even take a nap on it while sunbathing.

Learning to handle a sailboard is quite a change, even for an experienced paddle-

BASIC SAILING POSITIONS



Sailing positions are similar to those for any sailboat, but this one is a square rigger, so the wind pushes it. You steer by pivoting the mast in its socket, tilting sail.

Urheberrechtlich geschütztes Material

Water Sport

board sailor, because you have no rudder and must steer with the sail. You also have to learn to handle what is really a square-rigged ship rather than a fore-and-aft Marconi rig like that on small sailboats you have known.

What about safety? A basic requirement is that you be a really good swimmer. You are sure to spend quite a bit of your learning time in the water. Second, if you feel the wind is too strong for you, simply throw the sail kite overboard (make sure it's secured to the sailboard by a lanyard so you can retrieve it once the gust has passed). Third, if you feel yourself tipping, let go of the sail and dive overboard. That way, you won't fall and hurt yourself on the board. The sail in the water will act like a sea anchor, so the board will not drift out of reach. Then you simply climb back aboard, pick up the sail, and start over. When picking up the sail, get the wind on the underside and it will help you bring the mast into position. The wet sail will work even better than a dry one.

Although part of the fun of learning to handle a sailboard is falling off, a basic rule is to have someone with you in another boat in case of emergencies. If you tire from strenuous maneuvering, just throw the sail overboard and lie down on the board for a restful sunbath.

Building the sailboard. Frame the 3′-by-10′ flat deck with ¾″-by-2″ white pine. First cut three 10′ longitudinal pieces and fair each of these equally at both bow and stern ends. Begin the fairing about 25″ from the ends and carry it on an even curve to a thickness of about ¾″ at the ends. A bandsaw will be a big help in cutting these curves but you might use a saber saw.

Space seven crosspieces on 15″ centers and shape nosings from ¾″-by-1½″ white-pine strips for bow and stern.

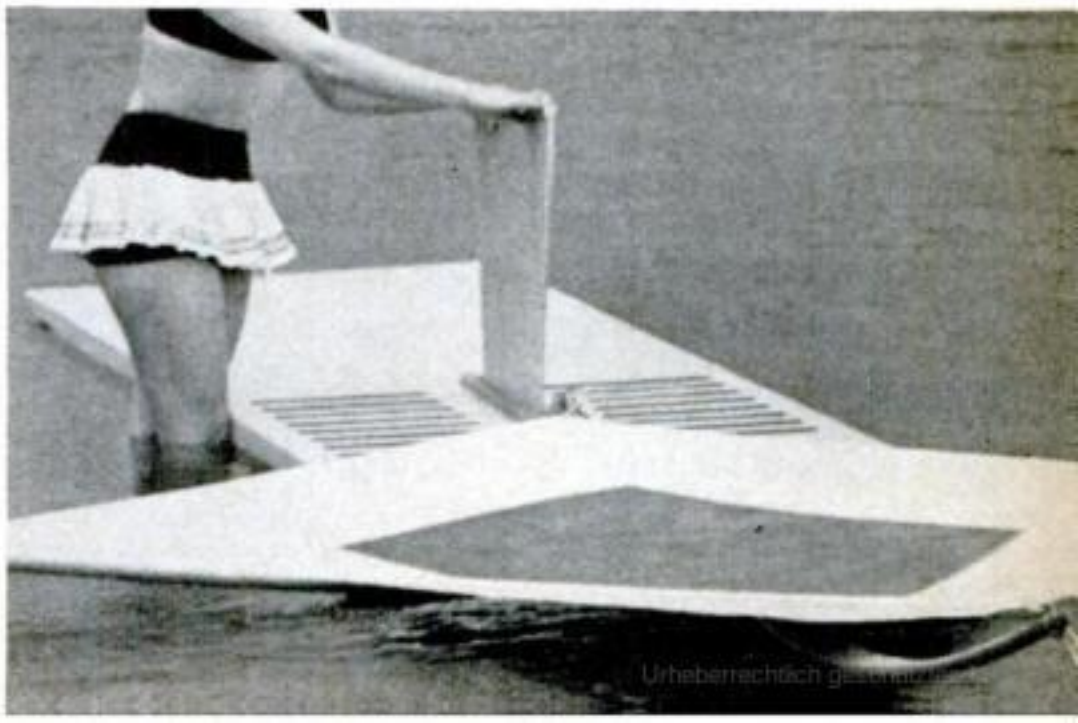
Cut 20¼″ from the center longitudinal at the point shown for the daggerboard. Form a slot by gluing and nailing ¾″-by-2″-by-36″ strips on either side of the remain-

CONTINUED

Square riggers can sail backwards as well as forwards. Called boxhauling, it's something like backing into a driveway to turn a car around in a narrow street. This is a handy maneuver that fore-and-aft-rigged sailboats don't use.

Mast and yard form a cross and should be bowed like a kite without having to overtighten sail, so that it cannot form a good airfoil.

Inserting daggerboard is the last step before mounting the sailboard and sailing. Note the safety strips of black antiskid tape on the deck.



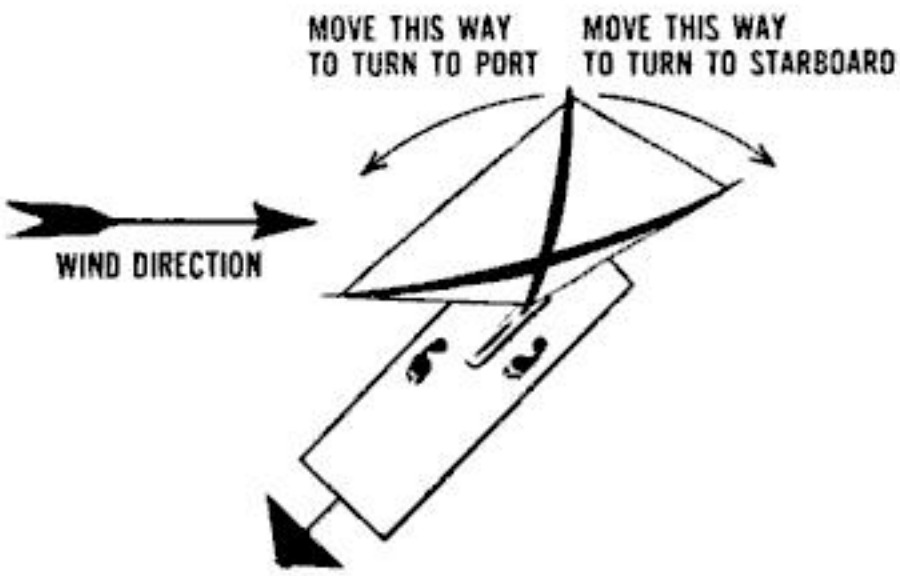
ing endpieces. Assemble all parts with waterproof glue and aluminum nails.

Plank the frame with ¼" marine plywood top and bottom. Make the daggerboard from ½" marine plywood with ⅜"-by-1" white-pine stops nailed and glued along the upper edge. The mast step and daggerboard trunk are made in one piece from ¾"-by-3½"-by-32½" white pine.

The mast is ¾"-by-3½" white pine or spruce 11'6" long. Taper it to 1¼" at the tips so it will bow to hold the sail. The yard is ¾"-by-1¾" white pine 8'4" long tapered to 1" at the tips. Round and smooth the edges of the mast and yard so they will be comfortable to handle.

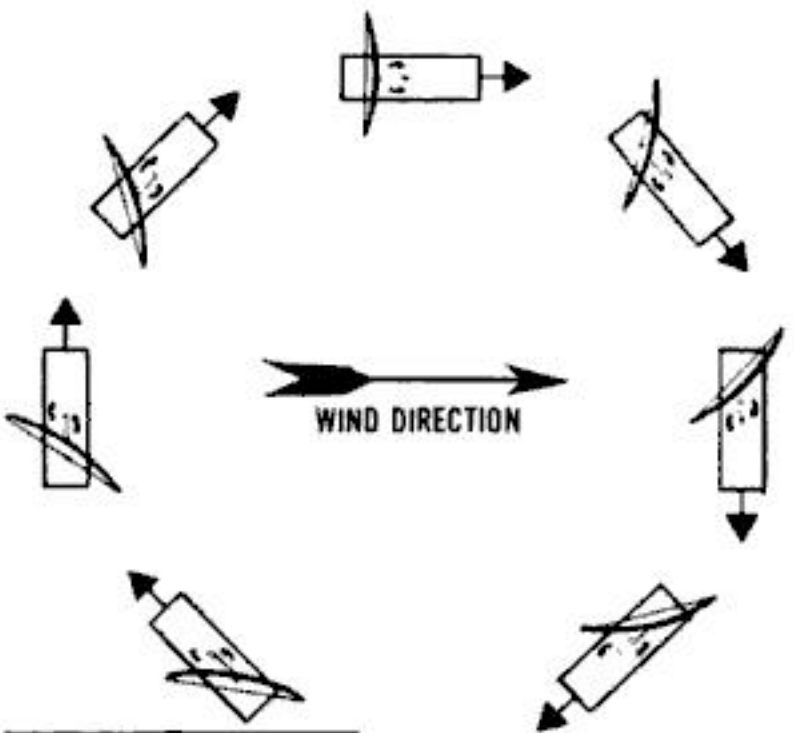
Sew the sail from Dacron or Egyptian cotton with rope in the outer edges for reinforcement. The drawing gives dimensions. If you'd rather not attempt to make it yourself, you can buy one ready-made.

[The author is producing a limited number of complete fiberglass sailboards to sell for about $270, knocked-down plywood kits (with sail and fittings) for $162, sails for $40, and finished spars for $32.50. For further information, write S. Newman Darby, 333 Park Street, West Pittston, Pa.] ■ ■



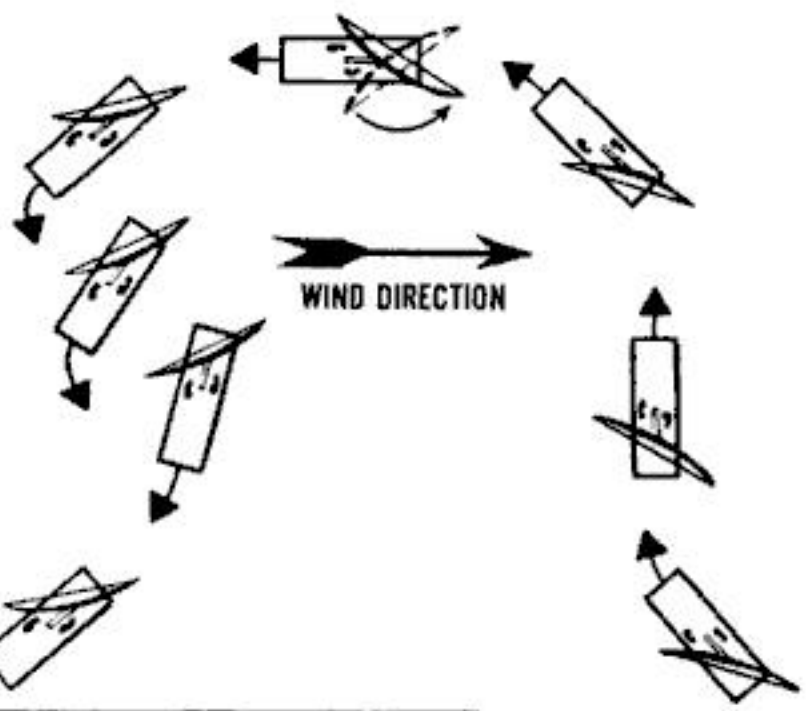
HOW TO STEER

Steering a sailboard is the same in tacking, running, and reaching. Keeping a positive angle of attack, pivot the sail to port to turn starboard, and vice versa. Beginners should practice steering while running with the wind before attempting other maneuvers.



HOW TO JIBE

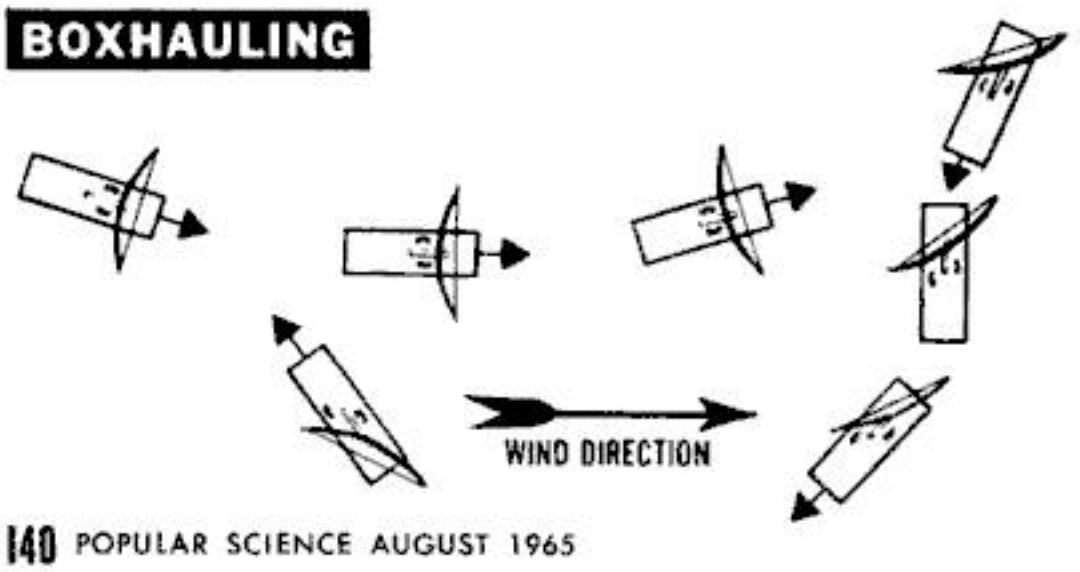
Jibing (or wearing, as it's called with square riggers) is easier for beginners than coming about because the wind is astern and pushes you around. There is no boom to come flying over as there is in a fore-and-aft-rigged sailboat.



HOW TO COME ABOUT

Coming about is harder than jibing, but it's a more efficient maneuver that loses less headway. Start by reaching to gain speed, come into the wind, quickly turn the sail 180 degrees, and start on the tack by reaching to build up speed.

BOXHAULING



Boxhauling is a slower way to turn than tacking but faster than jibing. Bring sailboard directly into the wind, then pivot sail aft so wind pushes you astern. Step forward slightly to keep stern from digging under. Tilt sail gradually to starboard to control turn. When you have come around enough, move your weight aft again and tilt sail to starboard. Reach to gain speed before turning into the starboard tack.

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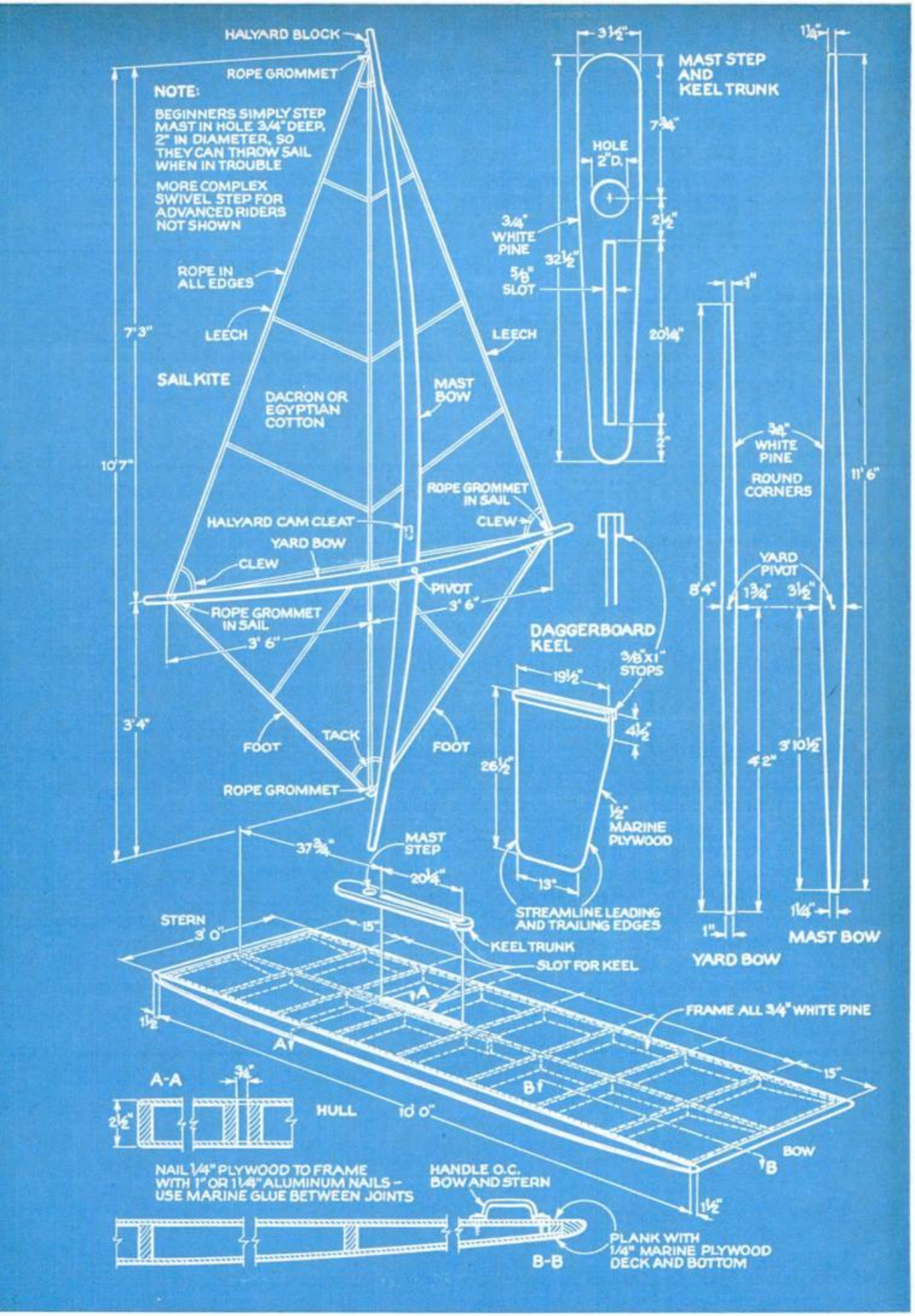

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HOW TO PICK THE RIGHT

Metal Finishes

Preparation and proper priming are the key to metal finishes that both protect and endure

By Jackson Hand

THE secret of metal finishing is priming. Adhesion, film life, corrosion protection, and colorfastness are all keyed to the use of the proper material next to the metal, no matter what the topcoat may be. Primers vary, metal to metal. As with wood—but more critically than with wood—the primer is a material compatible with the metal under it and the coating over it. In addition, metal primers nearly all contain chemicals that combat corrosion.

Primers for steel. Steel and iron need more protection than other metals because of rust. Most of us rarely work on new steel, since our possessions made of steel usually arrive already finished.

Primers for rusted steel contain a penetrating oil that digs down until it reaches sound metal. The accepted pigment for this primer is red lead. Red lead chemically inhibits further rusting by combating the acid that forms in the presence of water on the surface of the metal. A good primer for rusted steel may contain other chemicals, but the essentials are a penetrating oil and red lead.

If you can clean away all the rust, leaving bright metal, the proper primer is one containing zinc chromate, preferably in an alkyd-resin base. A silicon chromate is good, too. The alkyd provides adhesion. The zinc or silicon chromate provides anticorrosion protection.

There are other primers. Some of them are "mystery chemicals" that may contain red lead or zinc chromate or both, but usually hang their hats on some other ingredient. Some are quick-dry. Some are "cure-all." Some contain filler that tends to smooth out the rust, producing a smoother surface.

There are also products that claim to be both primer and topcoat. Since it is hard to make either a good primer or a good topcoat, chances are that the combination materials sacrifice desirable qualities. (For example, it is difficult to provide the excellent over-rust qualities of red lead without getting a certain softness in the final finish that may not be desirable.) Use the primer-topcoat materials only when the need for protection is less than stringent.

The anticorrosion properties of a primer are proportional to the thickness of the film. Do not brush out. Use two coats of primer over areas exposed to extra wear—such as corners and other protuberances. Many professionals spot-prime the hard-wear areas, then go over the entire project.

Do not expect much life from a primer that is not topcoated. Although it is sound practice to let a primer weather a week or so—or even up to a month—you eventually lose film thickness due to erosion. If you let a primer weather too long, it may be necessary to reprime.

Primers for galvanized. Galvanized steel is coated with zinc. The problem in painting it is adhesion. Most paints flake off. Special primers must be used—and America's millions of peeling downspouts are the proof. Some of the newest and best primers are based on polyvinyl acetate—a water-thinned formula that gives excellent adhesion and can be recoated quickly. Others are acrylic latex.

Remember, however, that galvanized metal with the zinc worn or eroded off is not galvanized. It is steel and should be treated as such. Nailholes lead water to the steel. Sharp bends often crack the zinc. Age will wear it off. When you paint galvanized metal, treat the steel parts as steel.

New galvanized is usually coated with oil

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PAINT FOR THE JOB

(from the manufacturing process) which must be removed. The easiest way is to let it weather for six months. Many painters wash galvanized with mild acid (vinegar would do it) before they paint it. This is not a satisfactory substitute for proper priming.

Primers for aluminum. Since the problem of overall corrosion is not serious with aluminum, and adhesion *is* a problem, the recommendation is for a primer in an alkyd-resin base, with zinc chromate as the pigment. There are special finishes for aluminum, especially clears, but their life is short, especially outdoors.

PS MATERIALS

Don't worry about the aluminum oxide that eventually coats aluminum that is exposed to air. It makes a good substrate for a zinc chromate primer, so long as it is not loose and dusty. Wash off loose surface dirt and oxides with a solution of phosphoric acid cleaner—available at paint stores.

As with galvanized, there may be manufacturing oils on the surface of new aluminum. Wash them off with a detergent or mineral spirits—or if possible allow a month or more of normal outdoor weathering.

Primers for copper. Treat copper the same as galvanized metal. Wash off oils—or let them weather off. If exposure has been long enough to allow an accumulation of greenish oxides, remove them with fine sandpaper. The purpose of the sanding is just as much to smooth the surface of the copper as it is to remove the corrosion.

Some paint manufacturers recommend acrylic-latex paint as a primer for aluminum, copper, and galvanized.

Topcoats for metals. Once a metal has been properly primed, you no longer care what metal it is. You pick the topcoat for the type of exposure. For instance, put a

CONTINUED

Your Priming Schedule for Common Metals

Metal	Preparation	Primer
Steel, bright	Wash with strong detergent, rinse. Or use mineral spirits	Zinc chromate
Steel, rusted	Scrape and wirebrush loose scaling rust. Dust	Red lead
Steel, painted	Clean intact paint; remove loose paint	None. If bright or rusted, see above
Aluminum, new	Wash off dirt, oil	Zinc chromate
Aluminum, weathered	Wash off whitish rust with detergent	Zinc chromate
Aluminum, painted	Same as for steel. Sand carefully to avoid scratching	Zinc chromate
Galvanized iron, new	Wash off oils with detergent or mineral spirits. Or allow 6 months' weathering	Polyvinyl-acetate base* or special alkyd base
Galvanized, weathered	Wash with detergent to remove dirt and oxides	Same as above unless rusted
Galvanized, rusted	Treat as rusted steel	Red lead
Copper, new	Wash with detergent or mineral spirits	Same as for new galvanized
Copper, old	Fine sandpaper to remove greenish corrosion	Same
Chromium	Wash with detergent or special cleaners, then mineral spirits	Protect with clear lacquer-type finish

*For nonrusting surfaces such as sound galvanized and copper, the polyvinyl-acetate primers have remarkable adhesion plus the advantages of water thinning and brush cleaning. The PVA coating is ideal as a substrate for any topcoat material. Equal results can be obtained with acrylic-latex primers.

Urheberrechtlich geschütztes Material

fine machine enamel on an outdoor appliance or yard tool; put a semigloss on garden furniture which must look more elegant than glossy (although the glossy would last longer). Keep in mind, however, that the objective is not merely cosmetic. One or two coats may cover, but an extra coat might give the protection you want.

What's in the offing? It has long been considered good practice to wash metals with a mixture of phosphoric acid and a detergent. You can buy cleaners of the phosphate type at auto-parts shops where finishing materials are sold. Phosphoric-acid metal preparations for home owners are also beginning to appear in paint stores.

There are two types. One is a plain metal cleaner. The other is a metal cleaner plus pigments that inhibit rust. The first is a tremendous aid to adhesion, but should be followed with a primer. The second is followed with the selected topcoat.

The pigments involved in these new products are not generally the well-known red lead and zinc chromate. Lead dust is used in some cases. It combines with the phosphoric acid to form lead phosphate as the antirustant. Other formulations produce iron phosphate over steel—or zinc phosphate in some cases.

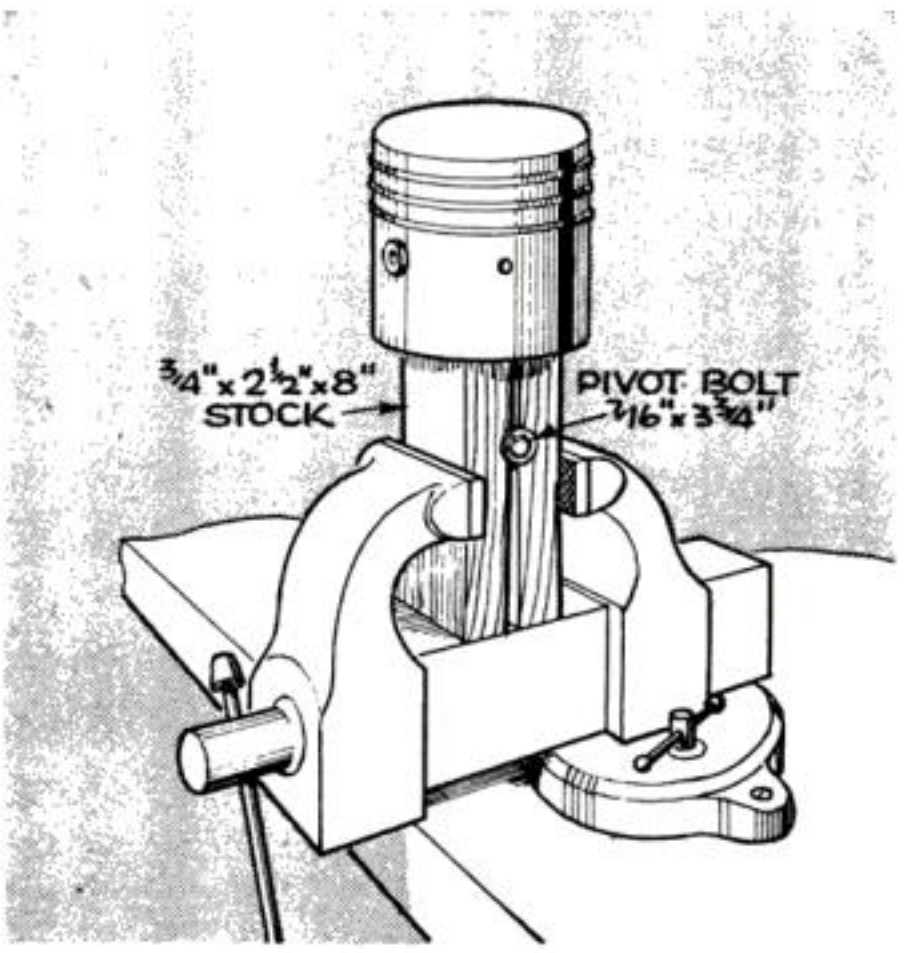
One of the newest ideas is the use of molybdates as the rust-inhibiting ingredient. Molybdates have not as yet been established as better or worse than red lead or zinc chromate as rust inhibitors. Their advantage lies in nontoxicity and in almost pure white color. In addition, they can be extended farther than, for example, red lead. Acme Quality Paints, sponsor of the molybdates technology, looks forward to the possibility of their use in areas where nontoxicity is a primary consideration—such as food-preparation machinery.

The whiteness, of course, means freedom in choice of colors. This may in time combine with the extendability of molybdates to permit primer-topcoat combinations of high performance.

The same promises seem inherent in barium-lanolate formulations being worked on by DuPont, involving nonelectrolytic chemicals quite new to common paint.

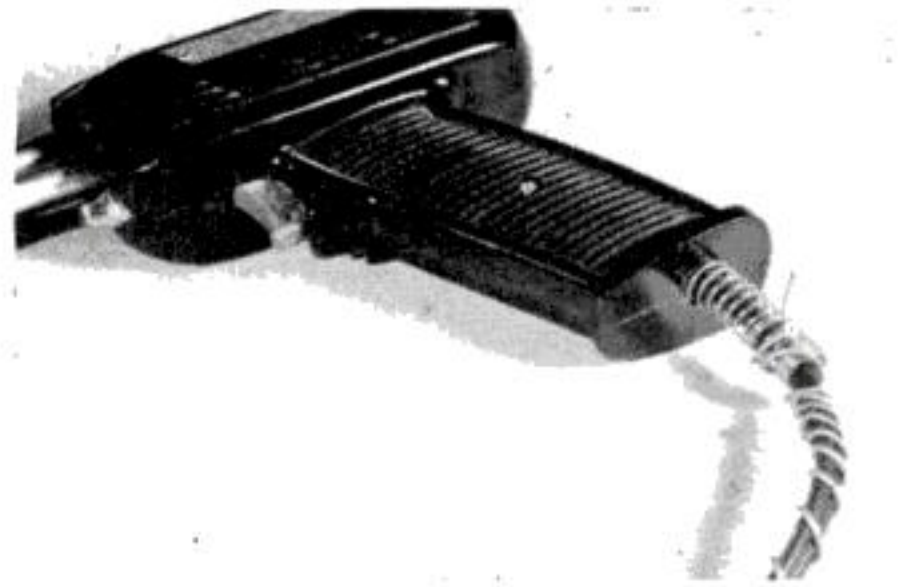
In large-scale metal painting—bridges, towers, etc.—National Lead has in full-scale operation a process of increasing the efficiency of red lead by coating it on silica. Less red lead is needed, yet it coats the metal with greater effectiveness. ■ ■

Short Cuts and Tips FROM PS READERS



How to hold a piston in a vise

When you tighten the vise on this piston holder, the two wood parts pivot on the 7/16" bolt, the upper ends spreading apart inside the piston and holding it securely. The upper ends of the wood pieces are shaped to fit between the piston bosses. The holder is very handy for such jobs as replacement of rings, cleaning ring grooves, and checking the dimensions.—*H. Miller, Vallejo, Calif.*



Always some solder in reserve

Keeping a short length of flux-core solder with your soldering gun will save you steps on many a job away from the workbench. Wrapped partly inside the spring that protects the cord where it emerges from the gun, and partly on the cord itself, the solder won't interfere in any way as you work.—*S. L. Walton, White Plains, N.Y.*

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[Continued from page 111]

fenderless bikes; thornproof tires for Southwest cyclists; and racing slicks for the getaway group. To all the above, add newly improved bike carriers for car bumpers and roofs, and it looks like good times for the country's 7,000 dealers.

The radical Moulton. With much activity taking place here, Great Britain—our chief bicycle rival—has not been idle. In the last two years she has exported to the U.S. more than a million cycles, worth $25 million. Most of these have been lightweights and club models, but now that radical new bike called the Moulton is about to burst on the scene.

In 1957, a Cambridge engineer engaged in suspension research for the British Motor Corp. (the Hydrolastic suspension system used in the MG and many other cars is his invention) decided to try his hand at bicycle design. Rather than try to improve the breed, Alex Moulton grabbed a clean sheet of paper and set out to challenge long-accepted bicycle theory: the upright riding position, crank-chain transmission, wheel size, frame shape, and size. After many experiments he kept only the first two principles.

What Moulton strove for was a maneuverable bike with a low center of gravity, plus great package-carrying ability. To achieve these, he decided on a 16-inch wheel. This was a sound move: Dunlop tire experts confirmed that rolling resistance depends more on tire pressure than on tire size. But small wheels created the problem of road shock. Moulton solved this with a coil-spring-and-rubber suspension system, fore and aft.

One bike for all. The use of flat-sided oval tubing enabled him to discard the standard "diamond" frame for an "F" frame, and to place the crossbar only 18½ inches above the ground. Thus emerged a genderless model that will fit anybody in the family from age 10 up.

With a weight of 32½ pounds, and with 60 pounds' tire pressure, the Moulton not only irons out ruts and bumps by reducing road shock 50 percent, but, to the experts' surprise, has proved as fast, if not faster, than conventional club bikes.

Moultons come in five models, the most interesting of which are the M4 Speed (turned-down handlebars, special gear options like 63-75-84-92, 17-inch wheels with tires that inflate to 200 pounds, precision five-pin cranks) and the M5 Stowaway (standard 16-inch wheels and a main beam that unlocks for quick takedown).

The Huffman Manufacturing Company of Dayton is marketing two imported models at $89.95 in the Los Angeles area, forecasting national distribution soon. Next winter, Huffman plans its own production.

Ever since Dr. Paul Dudley White, President Eisenhower's heart specialist, extolled the health merits of bicycle riding, more and more physical-fitness experts have jumped on the two-wheeled bandwagon. Add to this that it is one of the safest of sports and a fine family activity, and it's a sure bet that the bicycle will play an increasingly popular role in the space age. ■ ■

How to fit a bike

First select the correct frame size (distance of pedal crank to seat-post bolt): one that measures 9-10 inches less than your inseam taken in stocking feet. (A good rule of thumb: You should be able to straddle the top bar with both feet flat on the ground.) Next, adjust the saddle. Its nose should be roughly two inches behind a vertical line drawn through the crank center. For height, raise or lower the saddle until one stocking heel barely touches the pedal in its lowest position. The handlebars should be about level with the saddle top. For proper arm reach, your hand should just reach the grip when swung forward naturally. If it does not, you need a larger-size handlebar or an extension stem of a different length.

How to ride a bike

Bike riding can be enjoyed with half the usual effort. The chief trick is to use the right position and therefore *all* the muscles, not merely the legs. Particularly important are the ankles, which can add 25 percent more power to each stroke. Use them to point the toe downward on the downstroke, and allow each ankle to rotate on the upstroke. Other helpful tips: Press, rather than push, at midstroke; change your grip on the handlebar frequently; walk the bike occasionally. Above all, don't fight the hills. Select the proper gear (generally lower than you think) that will help you maintain a crisp but steady pace of about 70 revolutions per minute.

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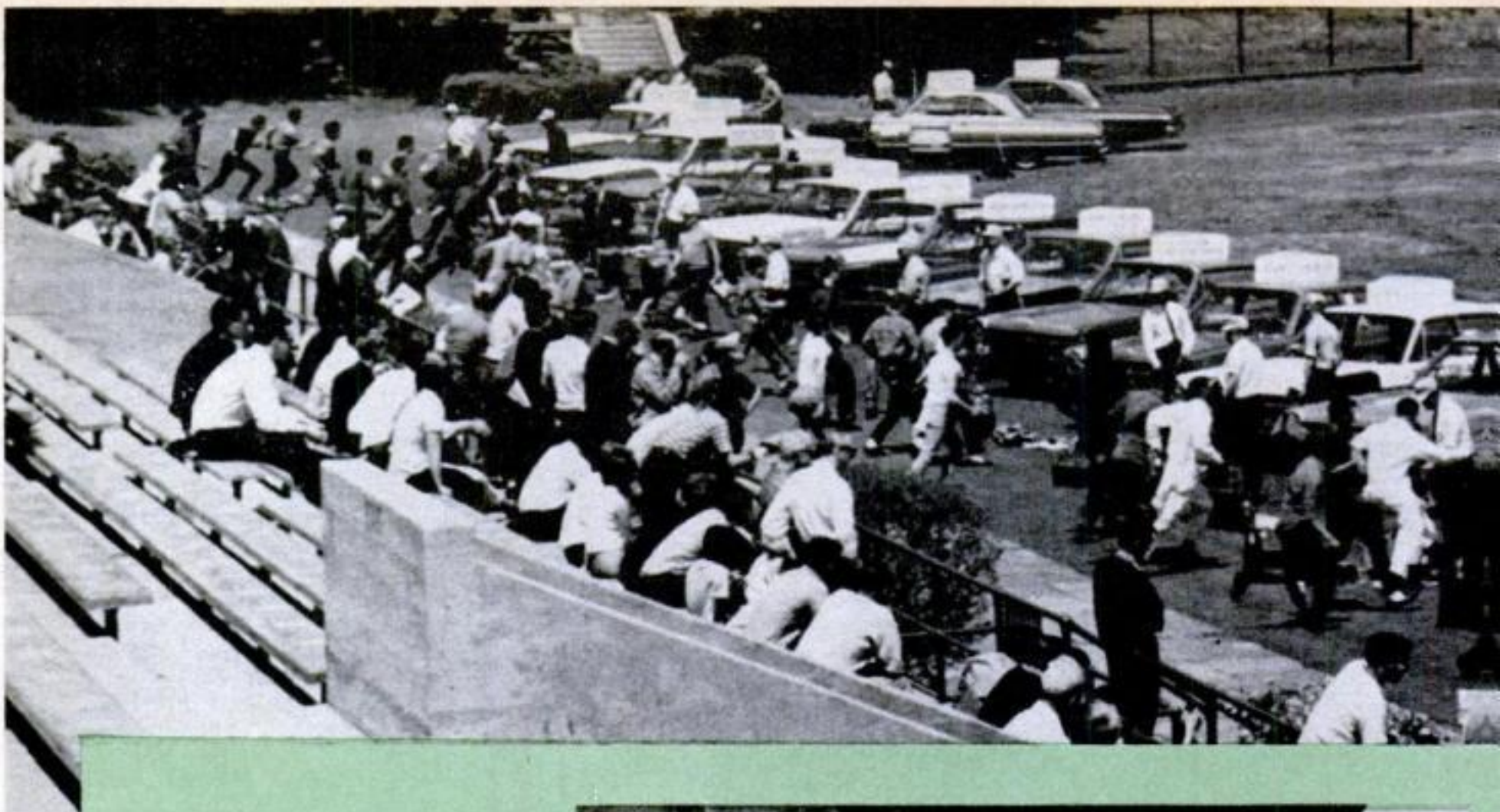

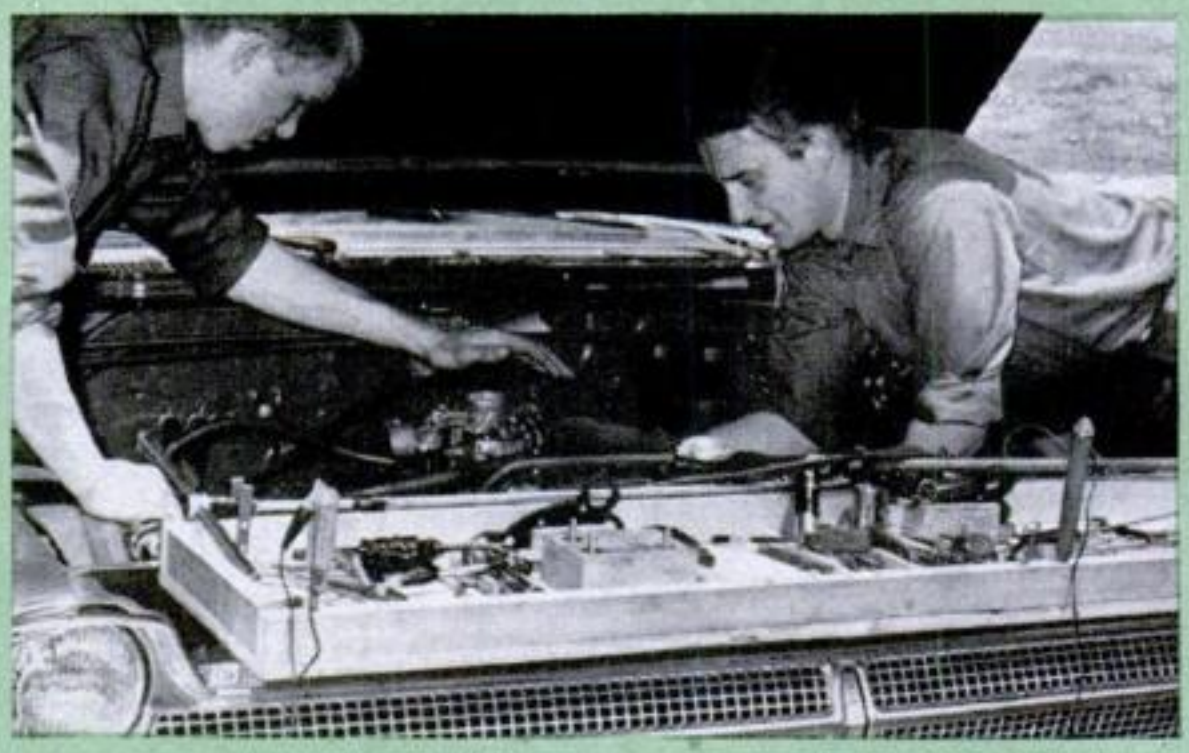

Local trouble-shooting champs saved time by having all the tools they needed mounted in this special tray clamped to front of car. Besides keeping tools handy, tray had special fixtures for mounting carb and distributor to make repairs easier.

They Fixed 16 Engine Faults in 31 Minutes

WITH time pressure hotter than the spring sun beating down on them, Roger Zahm and William Lichti tackled 16 deliberately baffling engine faults in a 1965 Plymouth V-8 to win scholarships and job offers in the New York regional contest. Also at stake was a crack at the 1965 National Plymouth Trouble-Shooting Contest finals.

It added up to a lot of pressure for teen-age mechanics, but this pair had a lot going for them. They'd been practicing for weeks—getting to their Mount Vernon school at seven a.m. and staying until seven p.m. for extra training—on top of a full class load. John Dini, who also prepared last year's regional winners, had these boys practicing on the same car that was before them in the contest.

System backed by theory might be the best way to tell how they did it. Following a set pattern, they checked everything by the numbers. First, off came air cleaner, carb, and distributor. Out came the plugs. Compression check. One works on fuel, the other on the electrics. No talking, just systematic checking, fixing, and moving on to the next unit. Roller bearings pop out of fuel hoses, distributor leads get sorted out. A nearby judge has any part required, but gives it only if requested.

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PS CAR CARE

Can You Beat the Trouble-Shooting Champs?

Here are 10 of the 16 malfunctions these young mechanics faced, and their symptoms. Could you have fixed them?

By Angus Laidlaw

1 *Your engine runs smoothly, but lacks full power and burns more gas than usual.*

You check spark at plug and find it good. Automatic choke opens properly. When you remove spark plugs you note that one or more of them are blacker than the others or fuel-wet. Putting in new plugs does not help. Compression test on these cylinders shows 30-65 p.s.i. compared with 135-150 p.s.i. on the others. Vacuum-gauge needle holds steady when the engine is idling.

2 *Your starter does not operate when you turn the key.*

You turn on lights and they work fine so battery is neither disconnected nor dead. Heavy cables to solenoid and starter motor check out for continuity and deliver current

CONTINUED

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In the interest of speed, these boys got into it with both feet. Others draped themselves over fenders, stretched out, and just plain reached to get at that rear-mounted distributor.

to the solenoid. Test light shows current coming to solenoid when you turn the key. Yet the starter does not operate and the switch does not click.

3 *Your engine starts, runs briefly, stalls, and refuses to restart.*

Your starter turns briskly. Holding a spark-plug wire close to the block shows a healthy blue spark. You remove the air cleaner, and work the accelerator linkage by hand; no gas comes from the accelerator pump. You remove the line from the inlet side of the fuel pump, place newspaper under the disconnected pipe and go back to the gas tank and blow into it. Enough gas comes through to wet the paper, so you know this line is clear. Disconnect the outlet pipe at the pump, and gas flows when the engine cranks. But there's still no flow of gas to the carburetor.

4 *Starter turns okay, but engine does not fire, or even sputter.*

You pull a spark-plug wire, hold it to the block and get no spark as the starter turns the engine. You yank the distributor cap, pull the coil secondary wire from the center terminal and hold it close to the block while cranking—still no spark. Turning the engine shows that the points open and close in an apparently normal fashion. You remove the primary wire from the distributor, and find it sparks when touched to ground. You touch it to the distributor terminal and it still sparks. You turn the engine so the points are open and touch it again; it still sparks.

5 *Your engine runs hot and lacks performance. On acceleration it spits back through the air cleaner.*

You check the cooling system and find

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everything all right. Idle air bleeds and idle-speed screws are correctly adjusted. The float level is not set too low, but the engine acts as if it is running on too lean a mixture. Occasionally you hear an unexplained whistling noise. The fuel pump is delivering the required pressure, and fuel lines and filter are clear.

6 *Your starter cranks, but the engine does not fire.*

You check the fuel system and find everything working right. A quick check shows no spark at the plugs, no spark at the coil secondary lead, and no spark at the distributor primary wire. Working back, you find no spark at the ignition wire on the coil. The wire is live at the ignition switch, the switch checks out all right, but the hot lead to the coil is not getting any juice. How come?

7 *Your starter turns the engine, but it doesn't even sputter.*

You feel sure the trouble is electrical, so your first move is to pull a plug wire and see if it sparks when held near the block and the starter turns the engine. Nothing. Checking back, you make the same test with the coil high-tension lead and get a fat, bluish spark. Distributor cap checks out okay. Rotor makes good contact with center brush. Where did the current go?

8 *Your engine backfires loudly when cranked and kicks back against the rotation of the starter.*

You check for spark and find a good, hot one. Carb seems to deliver fuel from accelerator pump, and besides, the engine ran all right before you worked on the distributor. Timing seems to be way out. But how can it have changed since you only replaced tired wires? You did not move distributor.

9 *Your engine shows a slight weakness and roughness, but doesn't run all that badly.*

You check the carb and find it all right. Fuel pump delivers full pressure so carb gets gas okay. Pulling a plug wire shows a healthy spark when the engine is cranked, but when you short out the plugs in turn with a screwdriver, you can feel little difference in idling with No. 8 grounded.

10 *After installing new points and working on the distributor, you find the engine refuses to start.*

You suspect the electrics, so bring out the timing light to recheck your work. The No. 1 cylinder is set correctly for static timing. Plug wires are in the correct order in the distributor cap. There is a good spark at the coil high-tension lead. Points are set correctly, but engine doesn't fire.

Answers on page 164

Bugged parts appear normal in some cases, like these (from left): condenser, points, rotor. But plug has gap closed and carburetor base gasket has a chunk cut out, to make faults easy to spot. At far right, ballast resistor could be checked electrically but not visually.

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Gus Gets the Show on the Road

By Martin Bunn

YAWNING as he walked the short distance to the Model Garage, Gus Wilson eyed the bright morning with little enthusiasm. It had been a warm night, and he had slept only in snatches. Today was going to be hot.

He could tell what it was going to be like in the shop. This hot spell would bring flooded carburetors, vapor-locked fuel systems, and overheated engines.

The sensible thing to do on a day like this was to go fishing. There was a place he knew only a few miles north . . .

Coming in sight of the Model Garage, Gus was surprised to see the door still shut, the gas pumps locked. Then he remembered he'd ordered Stan to pick up some parts and had intended to open up himself. He was 15 minutes late. As if in rebuke, the phone was ringing.

"This is Clyde Sims," said a familiar voice with a resonant echo in it. "Remember the hard starting I had last year? You said you could do something about it."

Gus fought down another yawn. "Yeah, we've found something that usually helps on that model. The carburetor soaks up too much engine heat in warm weather. Soon as you shut off the engine and fresh gas stops coming into the carburetor, what's in the bowl gets so hot it boils up out of the jet into the manifold. When you try to start, you get such a rich mixture a warm engine can't fire it.

"The fix is to install a thick Bakelite spacer between the manifold and carburetor. That keeps heat from traveling to the bowl so fast. Drive in and we'll put it in."

"Be there this afternoon," said Sims.

That was the kind of day it was going to be, thought Gus as he hung up. Changing to shop clothes, he doused his face with cold water. Stan Hicks, his assistant, arrived and unlocked the pumps.

The first service call came at 10 a.m. By then, the temperature was in the 90s. Gus sent Stan out and grumpily retired to a bench to overhaul a carburetor.

"There was this woman stalled in the shopping center," reported Stan on his return. "Nothing wrong except she'd flooded the engine. Why won't people learn that pumping the gas pedal shoots in more gas? All I did was hold the throttle wide open and crank the engine to clear it, but she acted like it was magic."

"Just your charm, Stan," said Gus, setting aside the rebuilt carburetor. "Keep it coming. There'll be more calls today. Drivers get panicky when a hot engine

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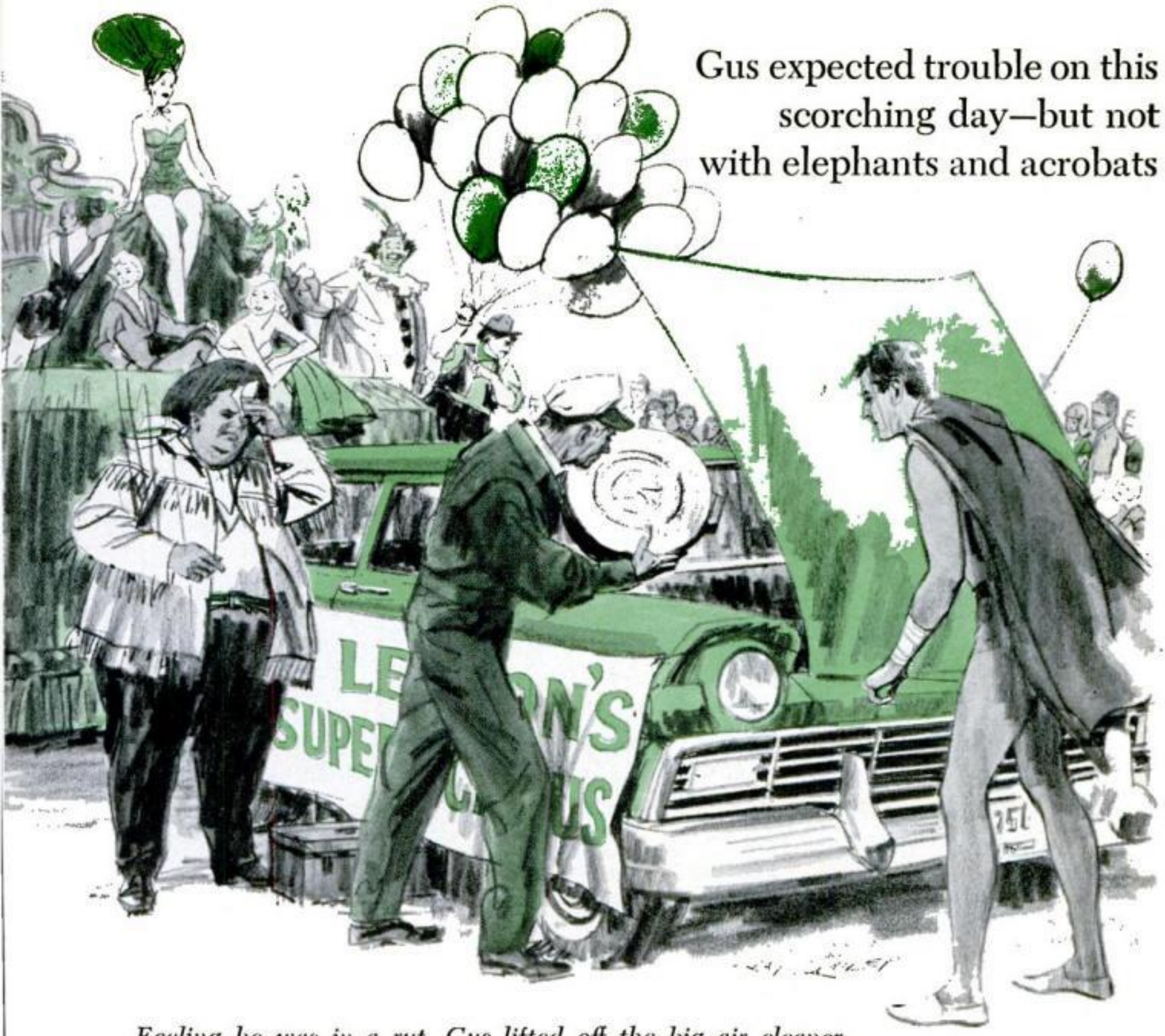
Gus expected trouble on this scorching day—but not with elephants and acrobats



Feeling he was in a rut, Gus lifted off the big air cleaner.

doesn't start, and react by jumping on the throttle. If the engine already has too much gas, that really does it.

"I remember one fellow who knew better. But he was sure the automatic choke cooled off faster than the engine block, and so choked a warm engine. He wrapped the choke thermostat with glass wool and asbestos to keep it warm. Swore it worked."

A horn squawked outside and Gus went out. An old Chrysler had evidently just been pushed in by a hubless two-color Ford, which now drove off.

A lean young man got out of the Chrysler. "She quit down at the corner," he said morosely. "See about it, huh?"

Raising the hood, Gus found no sign or smell of flooding. He loosened and wrung off the air cleaner.

"Try cranking it," he said to the driver.

As the engine churned over, Gus peered down the carburetor throat. The little stream of gas that should have squirted into it when the gas pedal was pumped wasn't there. He waved a hand, and the driver turned off the key.

"Second time it quit this morning," he said. "The first time, it started again after 10 minutes. This time, it stopped right in the intersection and a fellow was good enough to give me a push."

Gus had been checking. Fuel-line connections were tight, the flexible fuel hose seemed in good shape. Memory clicked to frame a question in his mind.

"What happened to that sheet-metal plate that used to be here, between the fuel line and the exhaust pipe?" he demanded.

"It was rattling. I took it off."

CONTINUED

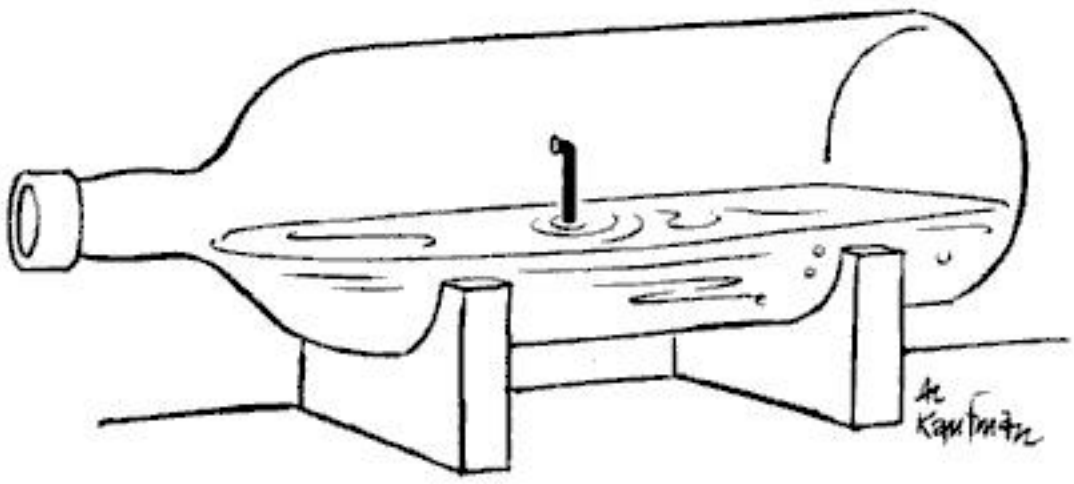
Urheberrechtlich geschütztes Material

"You've got a vapor lock," said Gus. "In today's heat, that hot pipe evaporates gas in the line. When the pump sucks in a vapor bubble, it can't deliver fuel. Here, pour some water over the pump. That may condense the bubble. I'll rig a shield in place of that plate."

The driver took the water can offered him and trickled a thin stream over the gas line and pump. Gus went inside for wire and sheet asbestos. Wrapping the asbestos around the fuel line, he wired it tight.

He nodded at the driver. The starter cranked for a few seconds. Then the engine fired. The young man paid and raced off.

Noontime came and went without further emergencies, and Gus began to think the day might turn out better than expected.



He was wrong. The trouble came with a telephone call.

"I was on my way to your shop," said the voice of Clyde Sims, "when the engine quit at Burroughs and Main. I'm making an awful traffic jam. Can you get here fast?"

Gus got into the wrecker and drove out. Two blocks from Burroughs Street, traffic slowed to a creep. At the next corner he spotted a parking place and continued on foot, taking his toolbox.

What he hadn't noticed before now grew louder—a calliope and brass band, sprightly tunes that sang of summer and peanuts, of elephants and acrobats. Even before he saw it, he knew the circus had come to town.

The parade had funneled into the other end of Burroughs Street, a narrow thoroughfare between the truck route and Main Street. But it hadn't come out. The stopper in the bottleneck was a 1957 Ford station wagon, flaunting circus posters as long as itself. It was towing a big float carrying several performers dancing and waving.

Standing across the path of the wagon was Clyde Sims' six-cylinder compact. From far down the stalled parade, music blared.

"GoshamIglad you're here!" The words tumbled out in Sims' deep voice. "When my car quit, I coasted in here to get out of Main Street traffic. But this circus car was halfway out. Together, we're blocking all but one lane."

Gus raised the compact's hood and got a strong smell of gas. "Been pumping the pedal?" he asked.

Sims shook his head. Gus got in the car and tried the starter, throttle wide open. After several turns, the engine fired, galloped irregularly, and died. Gus got out and removed the air cleaner. The automatic choke was properly open, but raw gas was dribbling into the carburetor throat, its odor mingling with the smell of circus wagons and animals.

"The engine was kind of knocking before it quit," rumbled Sims.

"Knocking?" He must be half asleep, thought Gus, not to have checked it before. Now he found the heat-riser valve and nudged its counterweight. It didn't budge. He tried harder. The shaft grated loose. He swung the weight over.

"This manifold valve is supposed to channel heat from the exhaust to the intake manifold when the engine is cold," Gus told Sims. "But it should open once the engine is warm. Instead, it was stuck in the 'heat-on' position. The hot intake thinned out air going through it, while extra gas boiling out of the carburetor made the mixture even richer. Try it."

Sims floored the throttle and turned the key. The engine caught on the fifth turn.

"Come to the shop," shouted Gus over the blare of horns. "I'll put special solvent on that stuck valve, check the float level, and put in the spacer."

Sims nodded, inched forward, and disappeared into traffic. From somewhere appeared Patrolman Ed Larkin, an ex-Marine whom Gus knew. After speeding on cars in both lanes for a time, he stopped traffic and waved the Ford out.

The wagon's engine revved furiously. It jerked the float forward, but as a boy scampered in front, it came to an equally jarring stop. Its engine stalled.

CONTINUED

Urheberrecht ch geschütztes Material

Open . . . drop in . . . shoot!

Kodak brings the Instamatic Camera idea to movies . . . and introduces a new era in movie enjoyment

Kodak has redesigned the movie camera. New KODAK INSTAMATIC Movie Cameras load *instantly*. Just slip the KODAPAK Movie Cartridge into the camera and shoot! No threading. No winding. No flipping. Zoom model shown, less than $160. Other KODAK INSTAMATIC Movie Cameras from less than $47.

Kodak has redesigned the movie film with 50% more picture area for better, sharper movies. The new KODAPAK Movie Cartridge is factory-loaded with improved KODACHROME II Film in the new Super 8 format —giving you 50 feet of uninterrupted shooting.

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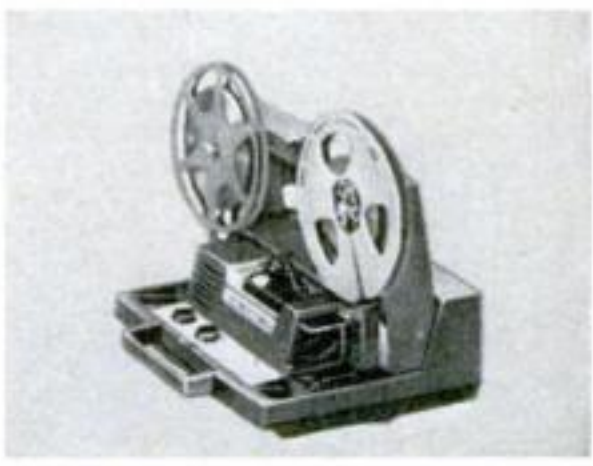


Prices subject to change without notice.

EASTMAN KODAK COMPANY, Rochester, N.Y.

Kodak
TRADEMARK

Larkin yelled at the boy, frantically beckoned the circus car on. Its starter ground, slowing ominously. The policeman strode over, face red and collar wilted.

"Your permit's for a parade, not for living statues," he roared. "Move it!"

The starter wheezed to a halt, and the music with it. From Burroughs Street came feline roars and monkeylike chittering. A florid man beside the uniformed driver of the wagon got out and looked back.

"Play! Keep playing!" he bellowed.

The band obediently started up again.

"The cats get restless in this heat," remarked the florid man to Gus.

"So do I!" roared Larkin. "Unless you're on the way in five minutes, you get a ticket *and* your parade permit revoked."

Taking off his Stetson, the florid man wiped his three chins and smiled weakly at Gus. "She stalls every time we stop—soon's we slow down from high speed. Always does, but it seems worse now. The heat, I guess. Some of the boys are right handy around engines, but nothing they've tried seems to do any good."

Two men hopped off the float. One, carrying a whip, went toward the animal cages. The other, a tall man in tights, a cape floating around him, came to the car.

"Break down and ask the man to give a look, Lendon," he growled.

"Sure!" bellowed Lendon. "I'd give every cent I have on me to get moving."

On the float, girl performers looked wilted under heavy make-up. The calliope and brass band finished a march separately. Somewhere a tiger snarled defiance.

Gus raised the hood of the Ford and, feeling he was in a rut, once more lifted off the big air cleaner. The choke of the two-barrel Holley carburetor was open, but again Gus saw gas trickling from the jets.

A right-angled rod, mounted in a boss on a side of the carburetor, extended across the flat top of the float chamber. Its vertical leg, encircled by a spring, stopped short of a lever linked to the throttle. Gus pulled the throttle open and let it snap shut. The rod did not move.

Using pliers cautiously, Gus bent up the flat lever until it lifted the rod, exposing a vent hole in the bowl cover. He opened the throttle and signaled to the driver. Slightly recovered, the battery spun the engine over a few turns.

It caught with a roar. As Gus released the throttle, it settled to a fast idle. He backed it off slightly, gunned the engine once more, dropped it to idle again.

As Gus closed the hood, Lendon yanked out his wallet. "Every cent on me, I said, sir, and that you'll get." He opened the wallet wide, stared into it, and shrugged.

"Cleaned out! But wait—"

With a flourish he produced two tickets.

"You're overacting, Lendon," rumbled the tall man. He folded a bill around the tickets and gave them to Gus. "That's only a loan, Lendon," he added, and swung himself back onto the float.

"It was the anti-percolating vent, of course," finished Gus as he told Stan of the incident at closing time. "The throttle linkage normally opens it at idling speed to release vapor pressure in the carburetor bowl and prevent flooding. The linkage was bent, so the vent stayed shut. Same trouble, different cause."

Stan pulled the big shop door shut.

"Too hot to go to bed early," he said.

With a grin, Gus produced two pasteboards. "I'm just waking up, myself. Let's go to the circus!" ■■

Bronco dragster starts on its "hind legs"

Dick Landy's 1965 Dodge Coronet Hemi-Charger generates so much torque that it rears up on back wheels at the start of a race at the Lion's Drag Strip, Long Beach, Calif. Earlier Landy won the Top Stock Eliminator title at the Smokers Drag Meet in Bakersfield with a speed of 138 m.p.h.

Urheberrechtlich geschütztes Material

"You need cooler plugs for hotter performance"

says Rodger Ward, two-time Indianapolis 500 winner

I don't know of any scientific way to pick the right heat range spark plugs that beats the old cut-and-try method. Engines vary. So do driving conditions. Plugs that work fine in one engine just won't hack it in another one that came off the same line!

We start with the heat range recommended by the manufacturer. We run for a while and yank the plugs. When you're running hard, you're apt to need cooler-than-normal plugs—especially with a modified engine. Fused deposits, fast electrode wear and cracking at the insulator nose indicate plugs that are too "hot" for the engine and driving conditions.

If you run across this, try plugs one step colder . . . they have insulators with shorter noses and are assembled deeper in the plug shell. They run cooler because they throw heat off to the cooling system faster. Generally, the coolest plugs you can run without fouling give you top performance.

Heavy oily deposits mean you need plugs with longer noses that run hotter to burn off those deposits. No matter what kind of plugs you run, don't just stick 'em in and forget 'em! They should be cleaned and gapped every 3,000 to 5,000 miles—and replaced at about 10,000.

And when you buy spark plugs, get Autolites. I use 'em racing and in my family car and plane. Autolite makes its passenger-car plugs with the same copper and glass seals used in racing plugs. It costs a bit more, so some companies don't bother. Autolite thinks the extra efficiency you get is worth it. So do I.

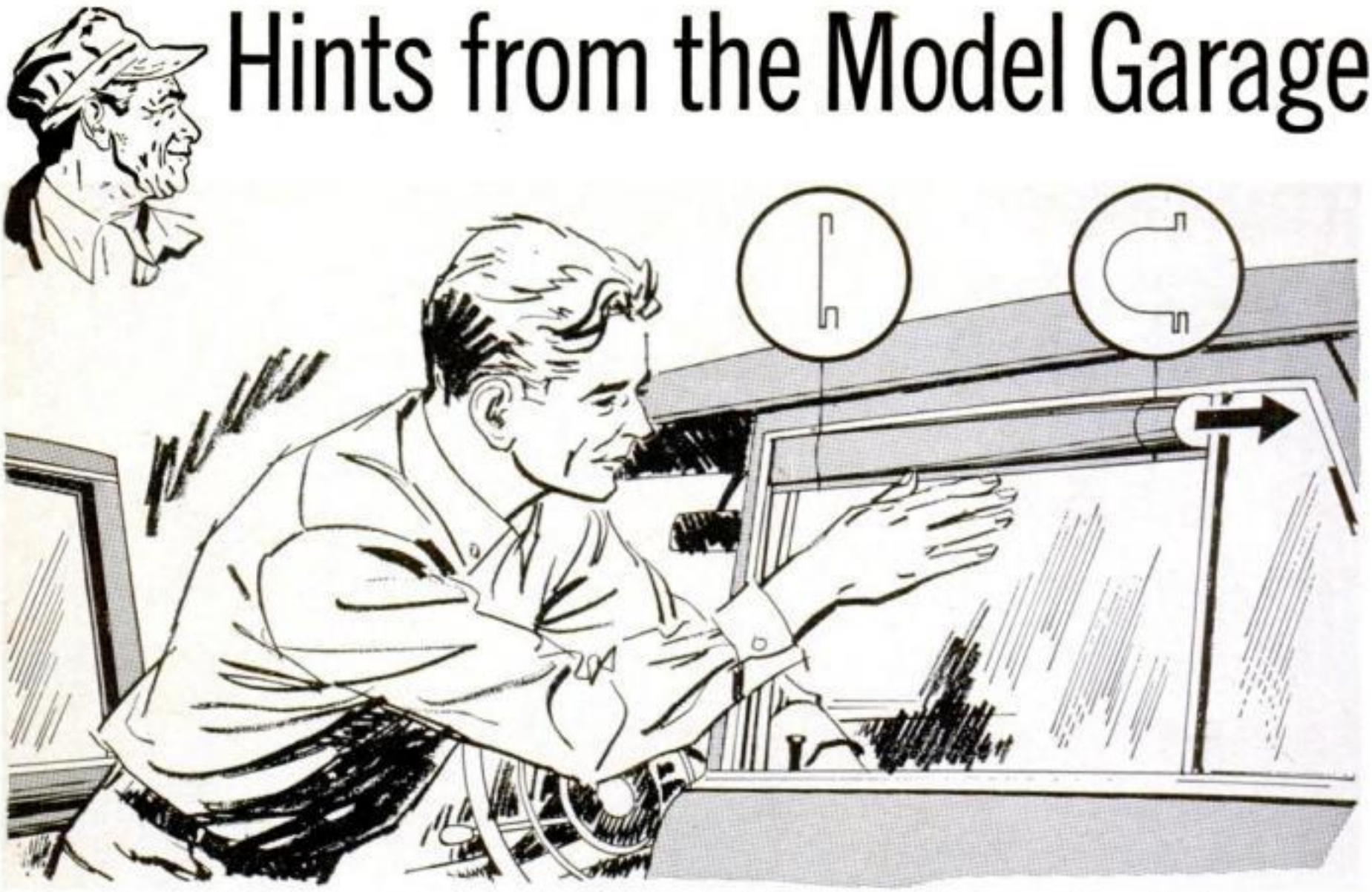
AUTOLITE SPARK PLUGS

PRODUCTS OF Ford MOTOR COMPANY

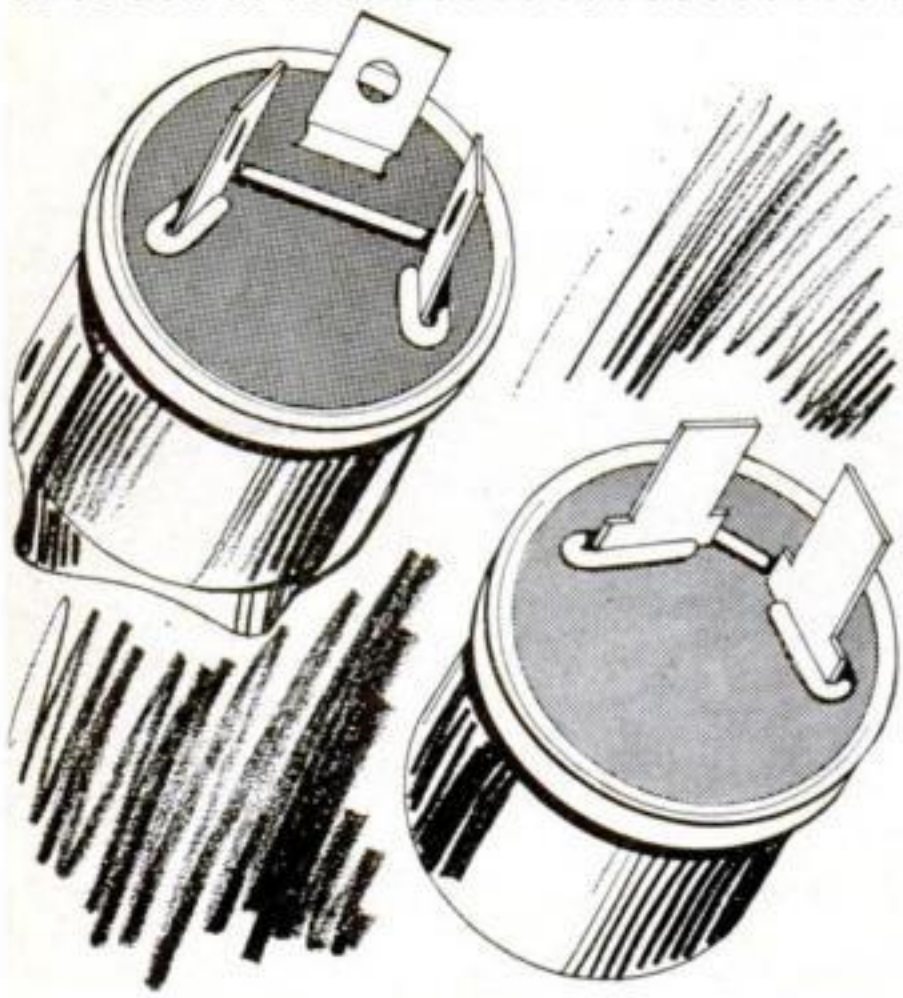
HERE IS A PARTIAL LIST OF RODGER WARD'S RACING ACCOMPLISHMENTS: Indianapolis 500—Winner, 1962, 1959; 2nd, 1964, 1960; 3rd, 1961; 4th, 1963. USAC National Champion, 1962, 1959. Winner of 25 USAC National Championship events, including 1963 Hoosier 100, Milwaukee 100, Sacramento 100; 1962 Trenton 150, Milwaukee 200, Syracuse 100, and many others.

Urheberrechtlich geschütztes Material

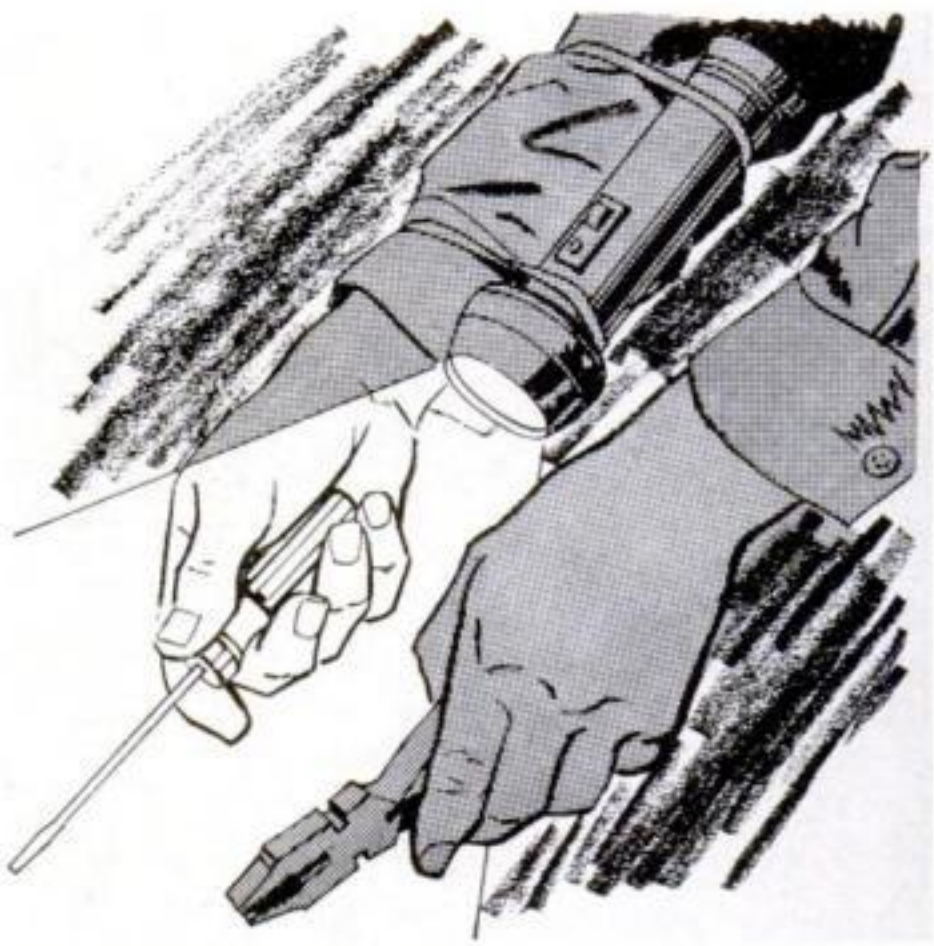
Hints from the Model Garage



Exhausting air from a car is a problem. You can always get outside air in, but on many cars the only way of letting it out is to open a window. Vent panes are noisy at high speed and also set up drafts that hit the passengers on the opposite side. The solution: Fabricate a piece of sheet metal, flat at the front and tubular at the rear, with gutters top and bottom to fit on top of the rear-door window glass and in the window seal. Hot and moist air is quietly sucked out. Paint the metal to match the car.



If your flasher unit fails, you can easily make a bypass, using a short wire (or a strip of folded metal foil) to connect the X and L prongs on the base of the unit. Refit the flasher unit in the socket and make flashing signals by switching on and off.



A flashlight should be part of your car emergency equipment. You can make your flashlight easier to use by putting a couple of large rubber bands around the handle. When trouble strikes, use the bands to hold the flashlight conveniently to your arm.

CONTINUED

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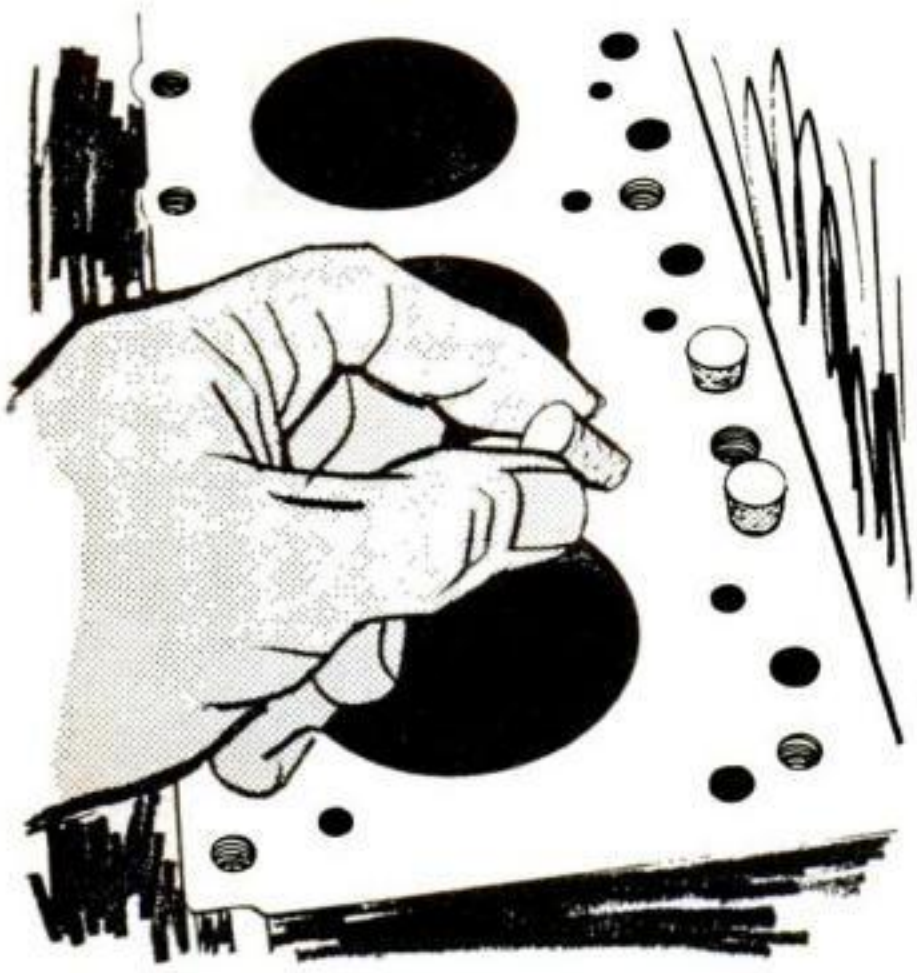
More Hints from the Model Garage

Waxing or polishing a car is less work if you use a regular mitt instead of cloths. The mitts are made in several sizes and usually have plastic or leather protective linings. Use one side to apply the polish, the other to smooth it down.

Bare spots on your mirror where the silver has come off can be fixed. Carefully remove the glass and cover the spots on the back of the mirror with tinfoil. Use clear, waterproof, adhesive tape to hold the foil securely, covering the patch completely.



Keep dirt and carbon out of the lifters by plugging up the pushrod holes whenever you're grinding the valves or decarbonizing the cylinder head. Ordinary medicine-bottle corks can easily be made to fit. Leave them in the holes until reassembly.

A leak in an external oil or brake line can be fixed by removing the line and screwing in Zerk grease fittings borrowed from the car's chassis. This will keep you going without an oil filter, or with three-wheel brakes, to the nearest garage.

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Some people spell performance "hp." We spell it "Wildcat."

Even though there's a deep-breathing, big-muscled 325-hp Wildcat V-8 under the hood, there's more to Wildcat performance than just horsepower. You see, we remember you've got corners to turn. And bumpy roads to drive on. And traffic to fight. So we harnessed our husky Wildcat V-8 to a crisp-handling, smooth-riding, utterly responsive chassis. And then made available our Super Turbine automatic transmission—so silkily efficient you'd hardly suspect it's putting traffic lights behind you so quickly. But enough talk. Time for action. Go see your Buick dealer and whisper the magic word. Wildcat.

Wouldn't you really rather have a Buick? A wild '65 Buick?

Buick Motor Division

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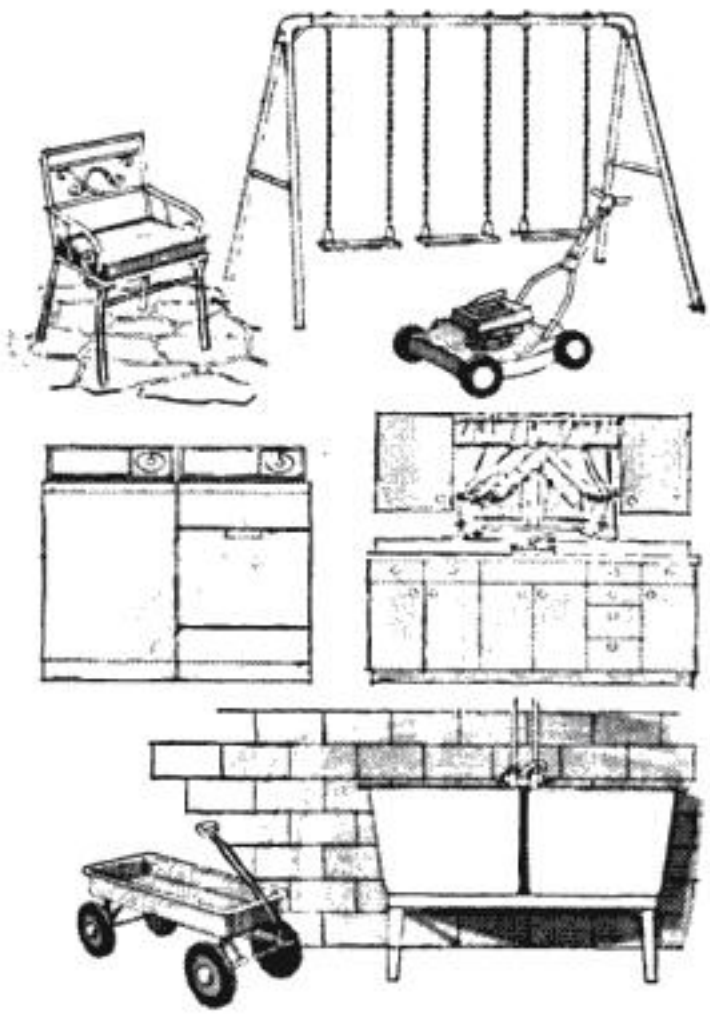
Don't paint it...



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Electric Power in Space

[Continued from page 59]

required by solar cells, and free of the radiation problems of nuclear power. Water produced by a day's run on fuel cells could be turned back into hydrogen and oxygen at a stationary electrolysis plant, run by solar or nuclear energy.

Solar cells, of which a bank makes up a solar battery, have a theoretically unlimited lifetime. The solar-cell-powered transmitter in our grapefruit-size Vanguard I satellite, launched in 1958, is still operating.

The output of solar-cell installations has grown from Vanguard I's tiny 0.06-watt power to 200 watts in our Mariner IV Mars spacecraft. For higher ratings, they become cumbersome, since a square foot of solar cells yields only a few watts. To avoid this drawback, makers are experimenting with flexible solar-cell "tapes" that can be wrapped around large space-vehicle structures.

Many orbiting space vehicles pass through the earth's shadow at regular intervals, but need a continuous supply of power. Solar cells must then be supplemented by rechargeable chemical batteries. In sunlight, the solar cells supply power needs, and also charge the chemical batteries; in shadow, the chemical batteries temporarily carry the load.

Atomic batteries use the heat given off by the natural decay of various radioactive isotopes, such as plutonium 238, curium 244, or promethium 147. Thermocouples turn this heat into electric current.

An atomic battery called SNAP-9A provides the 20-watt power of one Navy navigation satellite presently in orbit. SNAP stands for "Systems for Nuclear Auxiliary Power," of which a number are being developed jointly by NASA and the AEC for space use.

Radioactive-isotope batteries can supply up to several hundred watts of electricity for periods well over a year. For needs within those figures, they have now become competitive with solar cells.

Besides heat, atomic batteries inevitably emit a certain amount of undesirable radiation, against which a space crew and radiation-sensitive equipment must be shielded. Also, there is a potential hazard, when a spacecraft breaks up during reentry, of scattering radioactive material that will sink to earth, and may slightly raise the radiation level of a surface area. Some

Urheberrechtlich geschütztes Material

radioisotopes are less hazardous than others, and their use minimizes the risk.

Nuclear reactors provide power, not from radioactive isotopes that decay spontaneously at an invariable rate, but from a controllable chain reaction. This requires an amount of fissionable material, such as uranium 235, exceeding a certain "critical" mass. So a nuclear reactor would not make sense where only a few watts of power is needed, but it becomes attractive once we talk about kilowatts—especially several hundred kilowatts or more.

For example, nuclear reactors will find use in future high-powered TV broadcasting satellites—which, hovering in a "synchronous" orbit, will be capable of beaming TV programs directly into your home set.

They will be used, too, in manned planetary vehicles—whose long voyages will call for more comfort, and also for more radio-transmitting power, than is needed in orbiting the earth or in going to the moon.

And, speaking of the moon, nuclear reactors undoubtedly will be used to provide electric power for future lunar-base camps.

The first nuclear reactor in space, a 230-pound one called SNAP-10A, was orbited for trial last April. Its flight test proved that such a power plant could be subjected to a rocket launching and then be started and operated in orbit.

In SNAP-10A, thermoelectric elements turn heat from the chain reaction into electricity, and so there are no moving parts. Although SNAP-10A yields only 500 watts, the same thermoelectric principle can be applied to produce up to about 20 kilowatts. Still higher-powered nuclear reactors for space will heat steam or another gas, such as mercury vapor, to drive a turbo-generator.

Choosing a space-power system. How much power is needed, and for how long, obviously will enter into a designer's choice of which system to use. In addition, there is an all-important consideration:

The source of power must be extremely reliable. No single component's failure must ever be permitted to deprive a space vehicle of all its vital power. Hence, just as solar cells, atomic batteries, and fuel cells had to await thorough proof of their reliability before being adopted for use in space, so will other promising innovations in electric-power supply that are still in the experimental stage today. ■■

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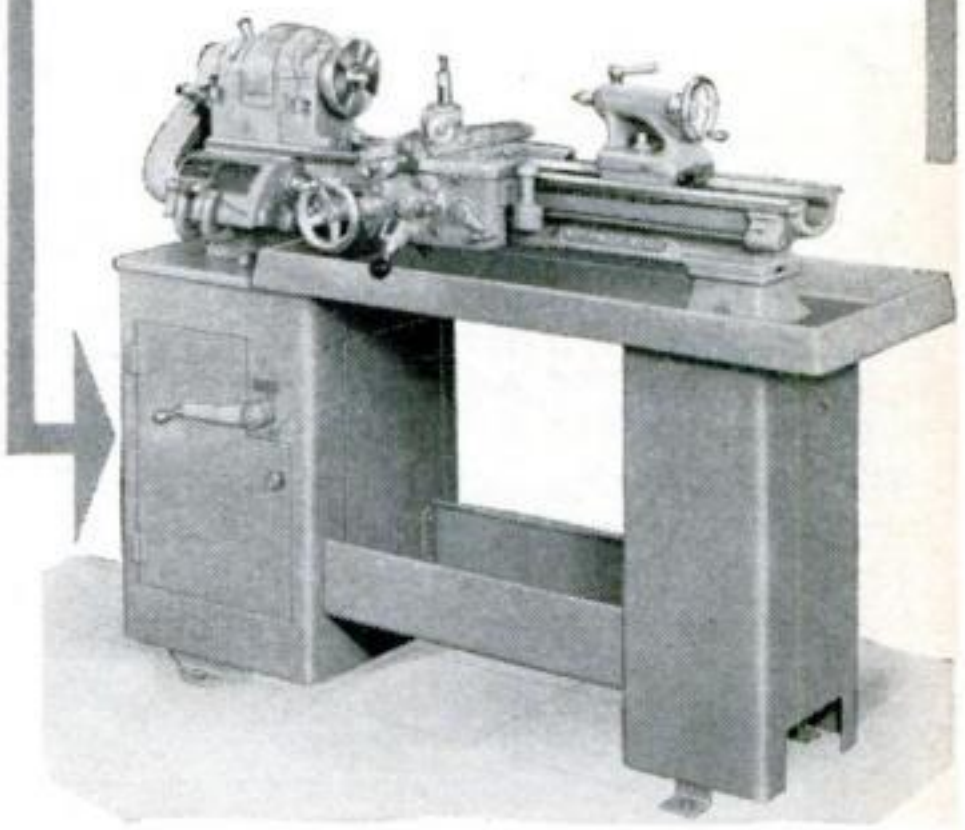

- New, trim floor legs . . . reinforced construction of welded, heavy gauge steel . . . maximum rigidity with minimum weight . . . no increase in price!
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- Superfinished spindles and bearings for uniform accuracy and fine finishes.
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Building Better Tools Since 1906

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[Continued from page 56]

traces of barium and antimony, which could come only from cartridge primers. Besides—and this is important—NAA proves its crucial point without in any way damaging the evidence. Chemical tests usually destroy much, if not all, of the samples.

How does NAA work? "Well," Dr. Guinn told me, "you take any kind of sample—it doesn't matter what: rock, glass, paper, cloth, hair, steel, anything—and place it in a low-power, low-temperature reactor. There it is bombarded with neutrons for varying lengths of time and becomes radioactive. Each element in the sample—except for carbon, hydrogen, and one or two others, which are unaffected—forms its own distinctive radioisotope. The more of an element in the sample, the more radioactivity it will give off.

"When we take a sample out of the reactor," he continued, "we simply look at it with a radiation counter—a gamma-ray spectrometer. Right away, we see a peak in the spectrum, and we say, 'Ah, that sample contains vanadium'—or whatever it may be. The size of this peak tells us how much of the element is present."

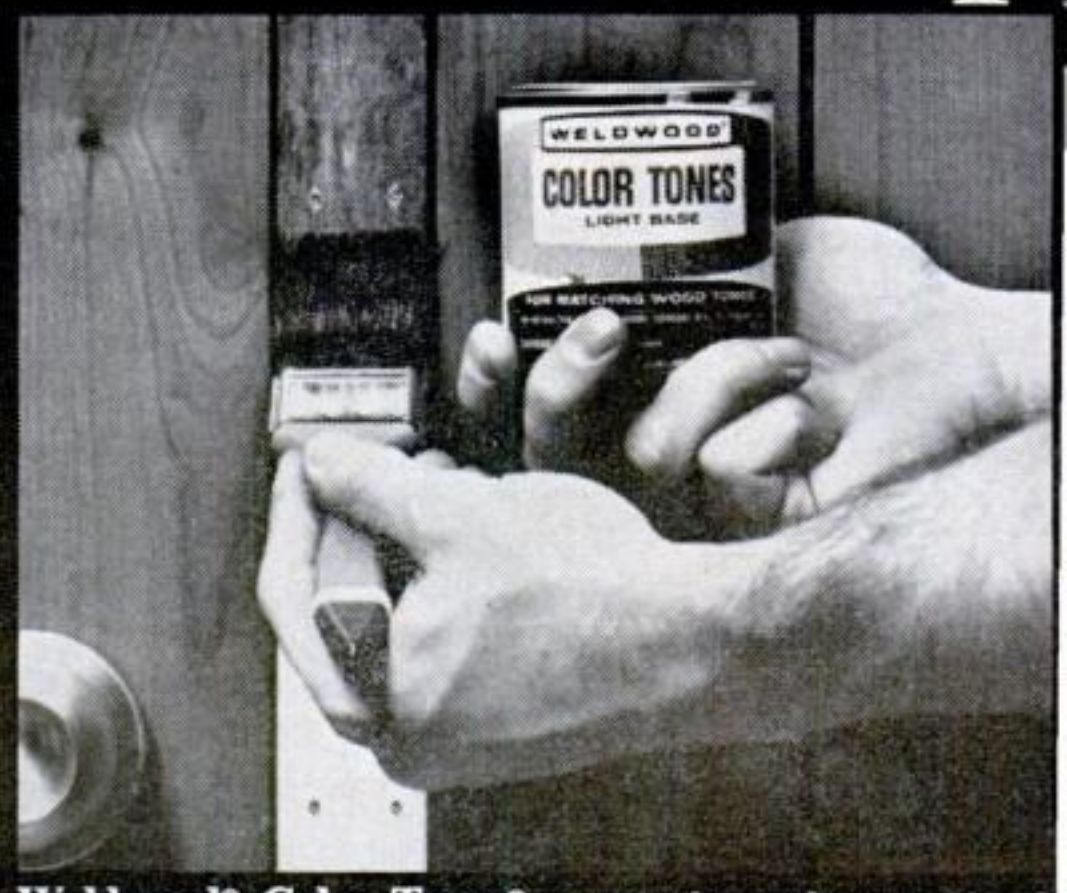
What is the smallest amount of anything that NAA can find? "Of typical elements," said Dr. Guinn, "we can detect about a thousandth of a microgram—or a billionth of a gram. That's 100 to 1,000 times more sensitive than any detection method used regularly by police departments."

With NAA, Dr. Guinn's group has been able to prove that so-called suicides were actually murder victims, and vice versa. They've helped trap rapists. More gratifyingly, they have occasionally been able to prove a suspect innocent of grave charges.

A code to catch killers. At present, NAA can plainly tell whether or not a person has recently fired a gun, but it can't specify the caliber of gun or type of cartridge. Even this problem may be solved if a "coding" plan devised by Dr. Guinn and his men is adopted. By the plan, cartridge manufacturers would insert different combinations of rare trace elements in each caliber of cartridge they make. No two manufacturers would use the same combinations. Police departments would be given keys to the codes.

The use of NAA in detecting gunpowder

Stick'em up, match'em up.



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residues has lately opened up another fascinating area of crime detection—determining whether or not a bomb explosion caused a plane crash.

The director of the Wisconsin State Crime Laboratory, a nationally known expert on bombing, is preparing and detonating various types of explosives and sending Dr. Guinn sample surfaces that the stuff has hit. Guinn and his colleagues are irradiating the samples, and hope to perfect an NAA technique that will determine beyond doubt if a plane's passengers have been sent to their deaths by a bomb.

The impossible penny. One of the most curious tales in the short history of neutron-activation analysis might be tabbed the "Case of the 1943 Copper Cent." Officially, at least, only steel pennies were coined in 1943 to help conserve copper.

One day not long ago, a man walked into the U.S. Treasury and took a conventional-looking copper penny out of his pocket. It was dated 1943.

"I'd like to have you tell me," he said to an official, "whether this is genuine or counterfeit."

"I can tell you right now it's a fake," the Treasury employee told him. "We didn't make any copper pennies in 1943."

"Look," the vistor said, "I'm a coin collector. I know what you say is true—officially. However, I still believe this penny is real, and if it is, it's worth thousands."

A thorough Treasury examination revealed that the stampings on the coin precisely matched those on genuine 1943 steel pennies. The crucial test would be an analysis of the copper content. But the coin could hardly be destroyed to make a chemical analysis. The only thing to do was turn it over to a special NAA lab group.

To the Treasury's dismay and the coin collector's delight, NAA showed that the 1943 copper cent had precisely the official composition of copper, even to trace impurities. It was unquestionably genuine, even if illegitimate.

The Treasury was forced to conclude that a 1943 employee of the Mint had run off just a few copper pennies surreptitiously. Whether he wanted them just for souvenirs or hoped to market them, no one knows. In fact, at this writing, the Treasury Department is still trying to find out whodunit. ■■

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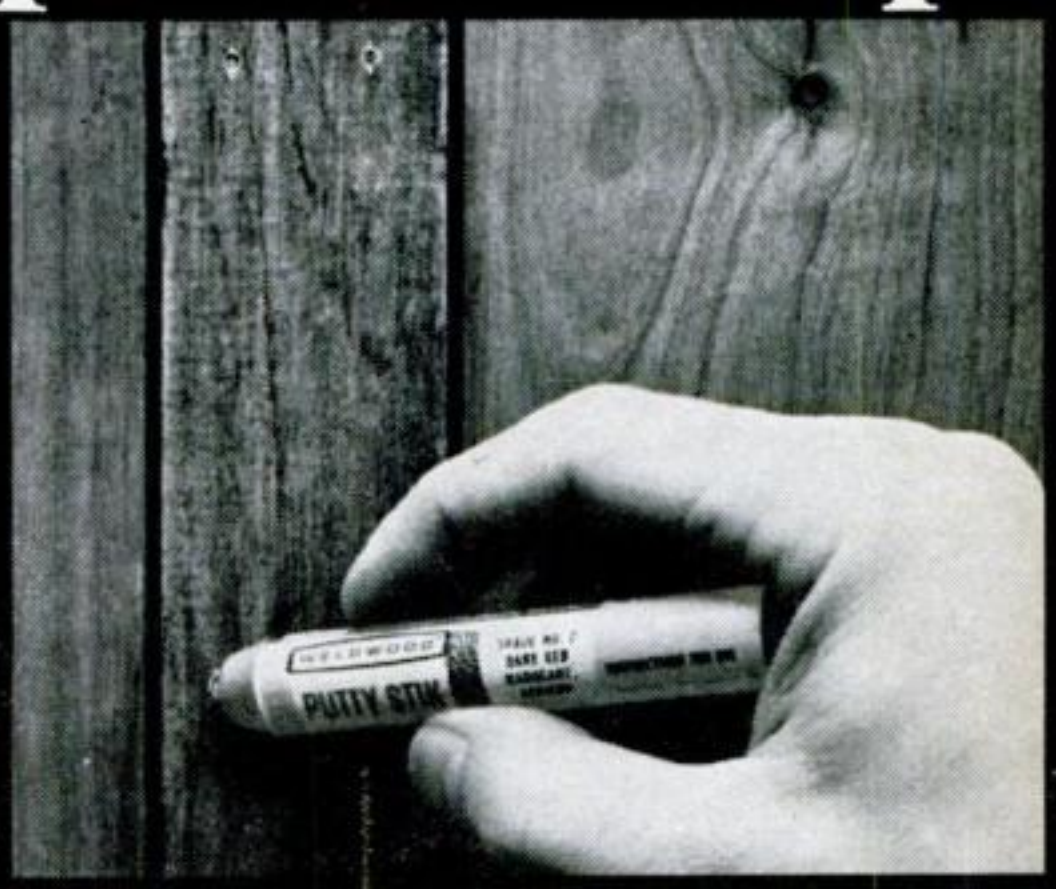

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Answers to Trouble-Shooting Quiz on Page 149

1 This is bad news. The clue is low compression on only one or two cylinders and nonfiring plugs. The cause is lost compression through burned exhaust valves. If the intake valves had been bad or sticking in their guides the vacuum-gauge needle would have fluttered. Check valve clearance, as tight valves tend to burn. The only cure is to remove the cylinder head and grind or replace valves. Contest simulated burned valve by tightening exhaust-valve clearance enough so valve could not close.

2 Neutral switch that grounds starter solenoid is disconnected. This is the switch that keeps you from starting the engine when the transmission is in "drive." Check wiring from solenoid to neutral switch and make sure the switch is grounded correctly. Normally the switch is always live, like the horn, and it's actuated by grounding. In contest, wire to neutral switch was disconnected and left hanging. To conceal the evidence, the bolt holding it was replaced.

3 In-line fuel filter is clogged completely so fuel pump cannot deliver gas to carb. Engine started and ran on fuel in float bowl, but when this ran out it stalled. In the contest, a clogged filter was simulated by plugging rubber lines to and from filter with bearing rollers. The giveaway clue was failure of the accelerator pump to squirt when accelerator linkage was operated by hand. This pointed to no gas in carb as the cause of trouble.

4 The condenser is shorted out or the breaker points are grounded; the effect is the same. Use your test light to see if the condenser is shorted (the light goes on when connected from a power source through the condenser to ground), or the points grounded (the light goes on when connected to the moving point when it is open). In the contest, the condensers were pierced with a nail to short them, and part of the nylon insulator was removed from the points to ground them, giving two causes for the same symptom.

5 Somewhere, you have an induction-manifold leak. The cure may be to tighten intake manifolds and carburetor mounting bolts, but chances are you'll have to find the leak and replace the gasket. In the contest, the carburetor base gasket was cut through at the rear.

6 The culprit causing this trouble must be between the ignition coil and the switch, and it is—the ballast resistor is burned out. The purpose of this resistor is to drop voltage to the coil and make the points last longer in a 12-volt car. Six-volt systems do not require a ballast resistor. In the contest this was simulated by cutting the resistance wires in the ballast resistor.

7 If the cap is good and the coil high-tension lead sparks, your trouble has to be with the rotor, and it is. The rotor is grounding out the high-voltage current before distributing it to the plugs. In your car this might be caused by a crack or carbon tracking, but for the contest, the rotor was drilled and a piece of solder inserted, grounding it to the distributor shaft.

8 Secondary wires have been installed in distributor cap one tower counterclockwise. This is an easy mistake to make when replacing a cap or rewiring. Timing being out is the clue. Avoid this problem by transferring wires to the new cap from the old, one at a time. Then, if you are careful, you can't scramble them. The cure is to replace the wires in the cap correctly.

9 Pull this plug and read it. If the firing tip is wet, it has not been firing. Perhaps metallic deposits have grounded it out, the insulator is tracked or cracked, or some foreign matter in the cylinder has bounced off the top of the piston and closed the gap. Even if it looks okay, try another plug anyway and chances are it will work. For the contest, the gap was bent closed and the plug replaced.

10 You have the distributor in exactly 180 degrees out of time, or backwards. When you removed it to replace the points, you put it back reversed. The distributor turns once for every two crankshaft revolutions, and so it would still check out correctly for timing. The cure is to remove the distributor and replace it correctly. Go by the book to avoid repeating your mistake. ■■

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POWERFULLY SMOOTH

with the ride that feels like a car...the Six that feels like an Eight

You've never ridden in any pickup with so much car-like comfort.

Its secret: *two* front axles—a Ford exclusive—that work independently to make the roughest roads ride far more smoothly.

Even on the best of highways, you'll enjoy the unique ride of Ford's Twin-I-Beam suspension. Gone completely is all riding harshness and pitch.

What's more, this truck corners without mushing out. It brakes to sudden stops without the usual dipping or diving.

Ford's new seven-main-bearing Sixes have the feel of a smooth-stroking Eight—the traditional economy of a thrifty Six. Or you can have a new 352-cubic-inch V-8, most powerful pickup engine Ford has ever built ...surprisingly economical too.

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'65 FORD

TWIN I BEAM
INDEPENDENT SUSPENSION

PICKUPS

BUILT TO LAST LONGER

Reason for Ford's smooth ride is exclusive new front suspension with *two* independent front axles. Shocks at one wheel are not transmitted to the other. Axles are forged I-beams as used in big-truck axles. Result: big-truck durability with car-like ride.

PRODUCTS OF Ford

RIDE WALT DISNEY'S MAGIC SKYWAY AT THE FORD MOTOR COMPANY PAVILION, NEW YORK WORLD'S FAIR

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"Tough customers are just the kind of used car buyers we like.

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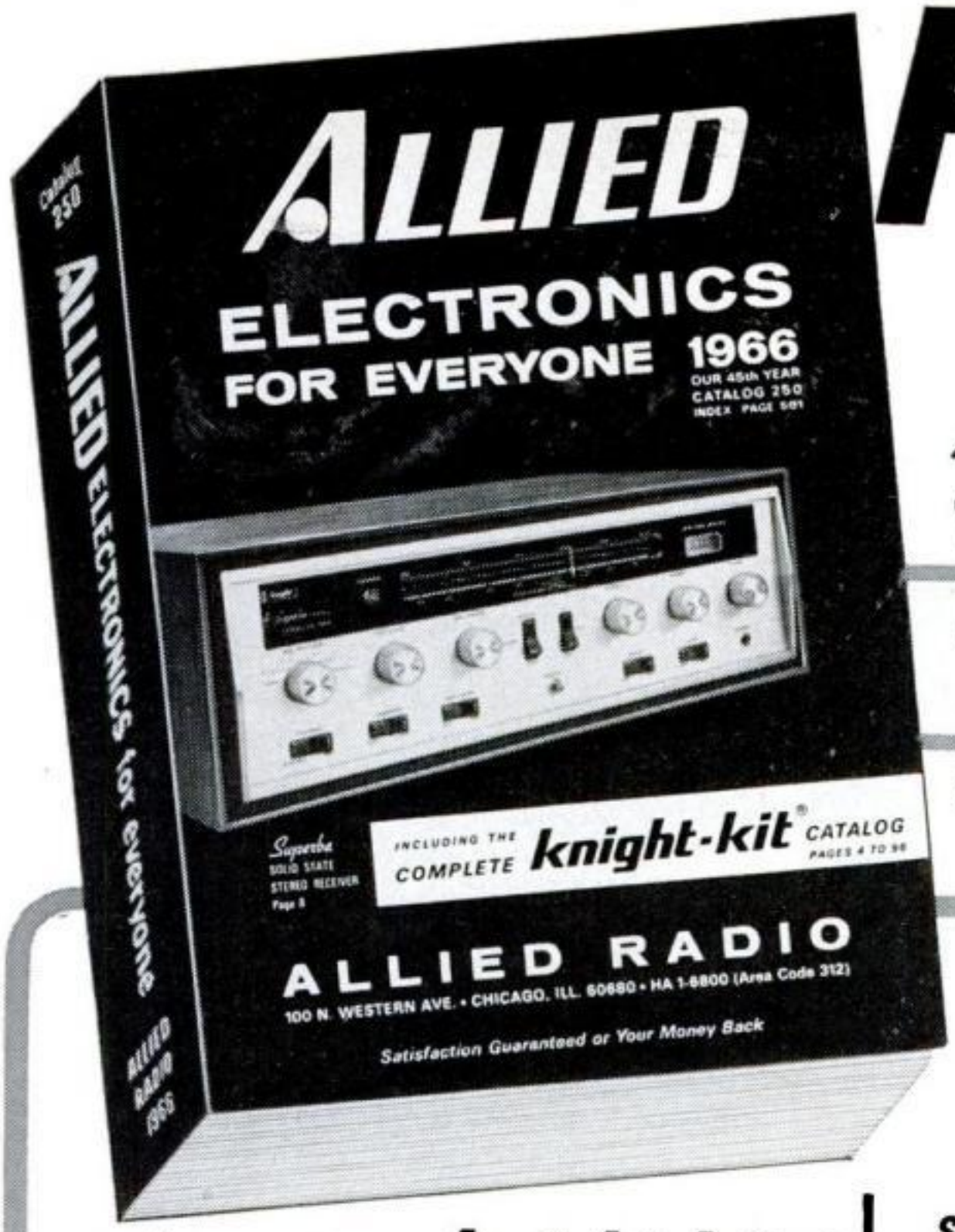

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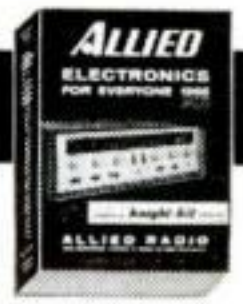

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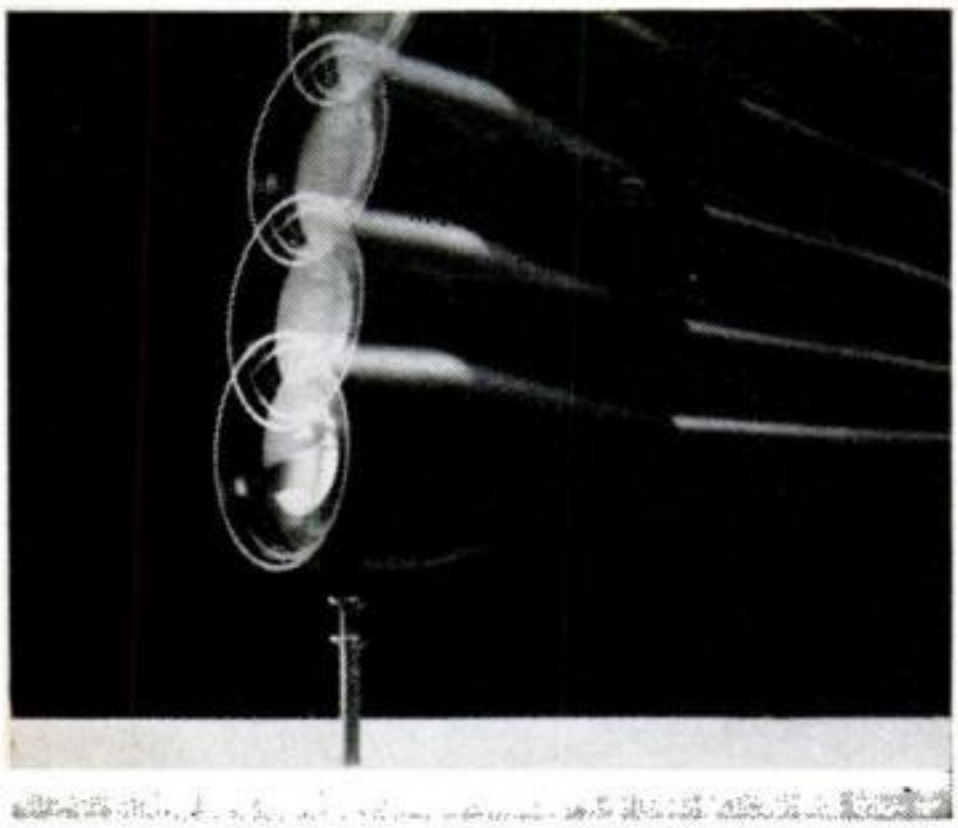

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BAUSCH & LOMB

RIFLE SCOPES

Be Your Own Weatherman

[Continued from page 120]

embodies a compass dial and saves you the trouble of making one. Remove the outer case and socket of this unit to expose the wiring.

Five wires emerge from each selsyn, but the two black ones should be connected together, so only four cable conductors are needed. Connect the 12-volt power supply to the red and black leads of the inside unit. Hook its black lead to the black of the roof unit, blue to blue, and so on.

As the selsyns are being operated on a lower frequency than they are designed for, the house unit may buzz loudly when the roof sensor turns it. This is normal and no cause for alarm. The power switch should of course be turned off after readings have been made. If children can reach it, you may prefer to use a normally off pushbutton switch instead of a toggle.

Make a small hardboard chassis for the electrical read-out circuits. Solder all connections. Use a four-pin socket to connect the temperature-humidity sensors, and a six-pin socket for the wiring from the rooftop units. Connections to adjustable resistors R1 to R5 are made to their metal housings and to one of the lugs attached to the resistance elements.

All the house instruments, the power supply, and the chassis can be housed in a standard metal case. To blend in with room decor, this can be enclosed in a wooden cabinet as shown in a photo. A second panel of brushed aluminum is mounted in front of the case panel, and a homemade slide dial may be built in for easy conversion of meter readings to actual temperature or humidity figures. Mount a plastic strip behind a slot in the panel. A paper strip on the plastic, lit by two pilot lights behind, has meter readings on its top line. The slide aligns these with equivalent temperature or humidity values (determined by calibration) on the lines below.

Your station's accuracy depends on how well you calibrate it. Set the small dial to the current barometric pressure from a local weather report and the needle will show your approximate altitude. Thereafter, always reset the needle to this altitude before taking a barometric reading from the small dial.

Line up wind direction by rotating the entire mast so that when the vane points due north, the house indicator does, too.

Urheberrechtlich geschütztes Material

Be Your Own Weatherman

On the I-81-A dial, the zero is omitted from the compass figures, 18 meaning 180 degrees, or due south, and so on.

If the anemometer spins without giving a meter indication, reverse the two leads from the motor. Speed is calibrated by varying R1, and the readings are linear—that is, if you set R1 so that a 20-mile wind reads .2 ma. on the meter, a 40-mile wind will indicate .4.

The best way to calibrate wind speed is with a hand wind meter held alongside the rotor in a steady wind. The hand wind meter is inexpensive and surprisingly accurate. Mounting the anemometer on a car and calibrating it by speedometer readings is far less accurate.

To calibrate for temperature, first set R3 to maximum resistance and R2 midway. Readings are *not* linear, so you must take several at different temperatures. Zero on the meter may conveniently be taken as 0 degrees, and full scale (1) as 100 degrees.

A good thermometer is needed. Leave it and the temperature-humidity unit in a home freezer, cool to zero, and adjust R2 so that the meter zeroes. Warm the unit (in an oven with the door open, or with a heat lamp) to exactly 100 degrees and set R3 to read full meter scale. You can adjust for other ranges the same way.

To calibrate intermediate readings, pack the sensor unit and thermometer in vermiculite, polystyrene chips, or other insulating material. Cool to zero again. The insulation will slow the thermistor's rise in temperature, after it is taken from the freezer, enough to let you get several low readings.

The humidity range may well be from 10 percent relative humidity at meter zero to 100 percent at full scale. The Hygropak is not linear in its response either. Borrow a humidity indicator to calibrate it.

Punch a hole in the cover of a big jar and cork it. Put the humidity meter and sensor case inside with an envelope or two of oven-dried silica gel, a material packed with photo equipment and with Polaroid color film. Use a gasket to seal the cover, and plug any gaps around the sensor cable.

As the silica gel absorbs moisture, humidity in the jar will fall and several readings may be taken. To increase humidity, remove the cork and breathe into the jar. For maximum humidity readings, remove the silica gel, put a little water in the jar, and warm it slightly. ■ ■

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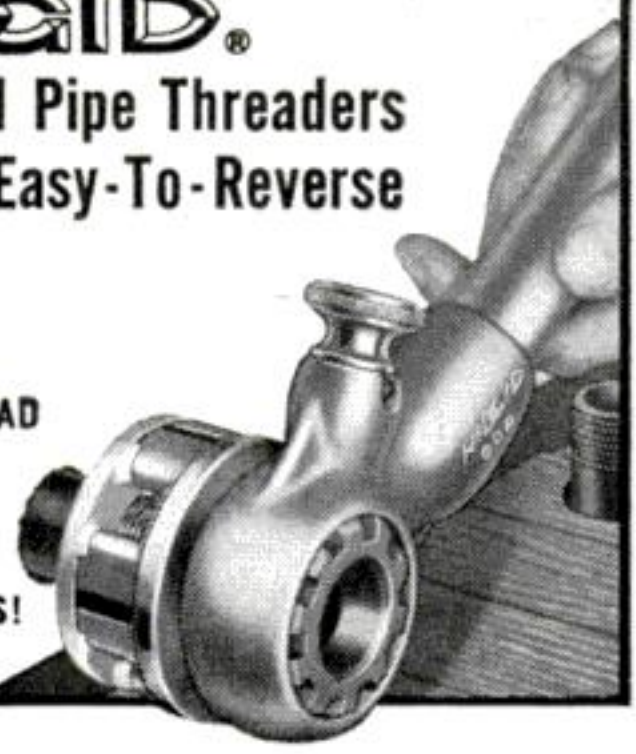

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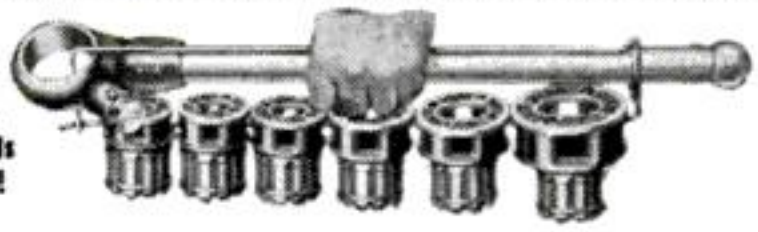

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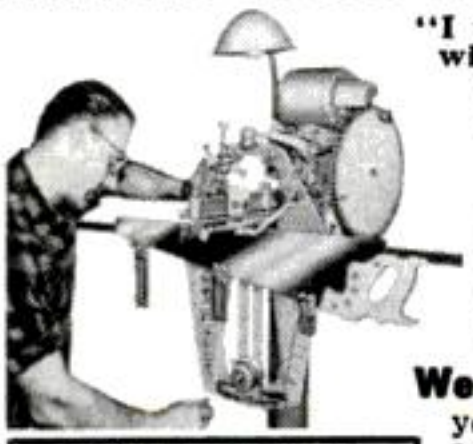

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[Continued from page 50]

charger that boosts output from 93.4 to 111.3 hp. Its maximum torque is developed at considerably higher r.p.m. than in other engines, but once you remember to keep the revs up, it will stay with the Nissan anywhere.

The Jeep has an overworked F-head engine (overhead intake, side exhaust valves), while Rover (whose three-liter passenger car has an F-head six) uses pushrod-operated overhead valves on the Land-Rover.

Transmission systems. Kaiser has the neatest transmission control, with a single lever sticking out of the floorboards. Full forward gives high range and rear drive. Pull back and you get, in succession, high range and four-wheel drive, neutral, and low range and four-wheel drive. On the Land-Rover I had to push down on a small lever to engage the front axle and move a separate lever for low and high range. The Scout and the Nissan Patrol have short separate levers for each function, but the manufacturers have chosen opposite patterns. Move the third lever all the way forward on the Scout and you get four-wheel drive. On the Nissan you have to pull it all the way back. Move the middle lever back on the Scout and you get low range—the same movement on the Nissan gives high range. Fortunately, most of us will never have to drive both.

The standard Jeep has a three-speed column shift, but a four-speed box is optional. The Scout and the Patrol have three-speed floor shift, while four-speed floor shift is standard on the Land-Rover. All of the gearboxes seem sturdy enough, but none offers a synchromesh first. The four-speed Land Rover has synchromesh only on third and top (perhaps because it will start off in second on level ground with light loads). Free-wheel front hubs and limited-slip differentials are available on all the ruggeds.

For sheer tractive muscle, the Rover takes the prize. First gear and low range give an overall ratio of 40.6:1, which compares with 35.2 in the Jeep, 30.6 in the Scout, and 24.5 in the Patrol.

Controls and interiors. I found legroom on the short side in both the British and Japanese cars. My accelerator foot soon got cramped in the Rover, and the lack of width in either cockpit gave me that straitjacket feeling on long runs. The American cars have plenty of width and allow for driving positions that tolerably fit the human

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anatomy. With the seat as far back as it would go, the steering wheel was still too close to my chest in all cars. The Scout is best, with 15.5 inches between backrest and wheel rim; then came Rover (15 inches), then Nissan and Jeep (both 14.5 inches). The U.S.-built cars put the wheel lower in my lap than the imported jobs, resulting in more restful arm positions.

Only the imported cars have decent instrumentation, with ammeters and oil-pressure gauges. The Scout and the Jeep use warning lights for amps and oil, which is a little too casual for my taste in vehicles designed to take a beating.

Starters and hand brakes. The Jeep and the Scout have key starters, the Nissan a pushbutton on the dash, and the Rover a well-concealed pushbutton *under* the dash. All the cars have manual chokes and hand throttles; none has a very convenient hand brake. I had to work a T handle with my left hand on the Jeep; the Scout has one you grab with your right. In the Nissan the hand brake is a floor-mounted lever next to the transmission; the Rover has a similar device, but it's horizontal and still harder to get to.

Getting in and out of the ruggeds is no problem, even for a gal in skirts. I could step right into the low-floor Scout; even with a four-inch door sill, total step height is only 20.5 inches. On the Land-Rover (22-inch step) and Patrol (22.5 inches), there are no sills. The Jeep has a high sill (28 inches), hence the stepping board at 15-inch height. The floor is seven inches down from the door sill. What you wind up with is normal seat height.

It seems paradoxical that go-anywhere cars are winning popularity at a time when highways are being built at a faster rate than ever before. But there are also more people with more specialized needs. Just the fact that the ruggeds are available has been enough to trigger a growing demand for them.

If the cars we tested don't fill your bill, the Alfa Romeo Matta, Austin Gypsy, Auto-Union DKW Munga, BMC Mini-Moke, Chrysler Farmobil, Citroën 2CV four-by-four Sahara, DAF Pony, Dodge Power Wagon, Fiat Campagnola, Mercedes-Benz Unimog, MV-Agusta Diana, Renault R-4 Sinpar, Steyr-Puch Haflinger, Toyota Land-Cruiser, or Volvo Laplander might.

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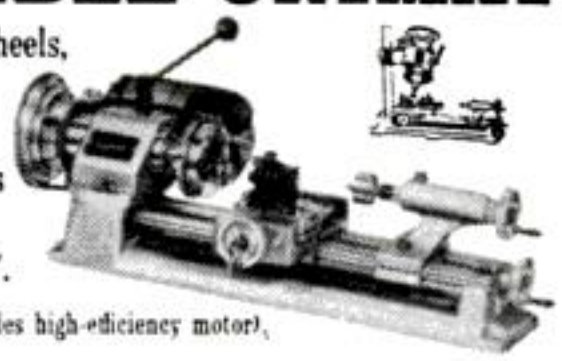

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Improving Your House Wiring

[Continued from page 127]

(frameless) hacksaw for the straight cuts. Remove a "knockout" in the top of the starting box by holding a screwdriver against it and tapping with a hammer. You can then push a stiff wire up through this hole to the wall opening where it can be pulled into the open. Use this wire to pull the cable down into the lower box for clamping and connecting. The upper box can be connected loosely before it is pushed into the wall.

If the cable from the switch box to the floodlight location runs down to the basement for an across-the-ceiling run, bore a ⅜" hole up from the basement into the base of the wall, as shown in a drawing. Then push a stiff wire up through the hole with a hook on its upper end. Push another one down with a hook on its lower end, and work it around until the hooks link. Then you can use the linked wires to haul a cable up from the basement to the box. If the cable is to run upward to the attic simply reverse the procedure.

The fixture holding outdoor floodlights must be a weatherproof type made for the purpose. In typical form its base is a corrosionproof (often aluminum) box with a gasket-sealed cover that carries a swivel-type flood-bulb socket. A gasket around the neck of the bulb keeps out water.

Weatherproof outlets. Outside the house, these are wired like floodlights, including the switch. You need this to shut off the current and eliminate tampering dangers when the outlets are not in use.

If the box is recessed in the outside wall so its outlets are flush, a standard indoor wall box can be used along with an indoor receptacle. The weatherproof cover protects both. Be sure its gasket seals the box and its cover lids seal the outlets. If you have any doubts about the seal between cover edges and wall surface, use a nonhardening sealer. The grounding wire from the cable and the jumper wire from the green-sprayed receptacle terminal must be connected to the box.

Loads and wire sizes. Most of the circuits in your house are probably protected by either 15- or 20-amp fuses. For outdoor lighting alone, you can connect into an outlet or junction box on a 15-amp circuit unless your lighting load is exceptionally large. If it's more convenient, however, there's no reason not to connect into a 20-

amp circuit. For outdoor plug-in outlets you should start from a 20-amp circuit to get the extra margin that small patio and lawn gadgets are likely to require. (For extra-heavy loads you need a special circuit, but that's another story.) One word of caution: Don't connect into a circuit that's already heavily loaded or into a 20-amp kitchen-dining-room circuit.

The smallest wire permitted in the cable of a 15-amp circuit is No. 14. This is easy to form into loops at terminal screws and easy to flex into boxes.

If you're starting from a 20-amp circuit. the National Code calls for a minimum of No. 12 wire. This is a little bigger, a little stiffer-working.

Grounding. This is vitally important in outdoor wiring because you may contact an outlet box or fixture while standing on damp earth. So your starting box *must* be well grounded, as the grounding wire in your new cable will continue that ground to your new boxes or fixtures. You can test the ground with a 30-cent insulated pigtail bulb socket. With current off at the main switch, connect the black wire from the socket to the black wire in the box. (In an outlet box you can do this at the brass terminal.) Connect the white wire to the box itself, under a screwhead or with a clamp. Then screw in a bulb. If it lights when you turn on the current, your ground is okay. If not, check your inspector for approved grounding.

The National Code permits you to run a grounding jumper wire from the box to a ground clamp on a nearby water pipe—if the pipe is part of the same system to which your fuse panel is grounded, and if the part you'll use is in good electrical contact back to the fuse-panel grounding point. You can use the pigtail socket to test it by connecting to the black wire as before, with the white wire to the pipe.

Grounding is important in terms of safety for this reason: If, through insulation failure or other trouble, the black (hot) wire comes in contact with an ungrounded metal outlet box, the box becomes live. If you touch it while in contact with a grounded object, or while standing on wet ground, that might be the last act of your career. If, on the other hand, the box is grounded to the same ground as the fuse panel, a fuse will blow when the black wire contacts the box. ■■

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[Continued from page 45]

of rotors or propellers, or by moving a small mass of air at very high velocity with a jet engine. However, as the speed of the airstream being moved increases, the power required rises very sharply.

Thus jet engines are very hungry—much more fuel is required for a given amount of thrust than with a propeller-driven aircraft. In this respect the helicopter is the most efficient lifting machine—but its speed is sharply limited. An airplane can't move forward any faster than the rearward velocity of its propulsive airstream (can't move *as* fast, in fact). This limits propeller-driven planes to around 450 m.p.h.; jet engines, on the other hand, produce airstreams moving at 2,000 m.p.h. or more, so jet planes just naturally want to fly at supersonic or high subsonic speeds.

Some engineers think the answer is a hybrid such as the GE-Ryan XV-5A, which uses its jet engines to spin lift fans for vertical flight, then converts to pure-jet propulsion for forward flight. In Europe, though, the emphasis is on jet-lift engines. These can be built to produce high thrust with low weight, which may offset their low hovering efficiency. However, the Hawker Siddeley P.1127 jet, which can go supersonic and is one of the most successful VTOLs yet flown, can carry only enough fuel for a total flight time of half an hour.

The prop jobs. In the U.S., the major emphasis is on propeller-driven VTOLs, which are the prototypes of small transports rather than high-performance fighter planes. But the U.S. is watching with interest European development of jet-fighter VTOLs; in fact, we are now participating with England and West Germany in a six-month cooperative evaluation of a squadron of nine P.1127s under operational conditions.

The first uses of VTOLs will be military. Within two or three years it's likely that there will be an operational VTOL jet fighter and a propeller-driven small VTOL transport for carrying troops and supplies in limited-war situations. France is closest to having a VTOL fighter: the Mirage III-V (based on the Balzac), due to fly this year.

The major benefit to civilian transportation is likely to come from the military VTOL transports, which will be the basis for short-haul airliners capable of landing and taking off at any town, and requiring no airport. ■■

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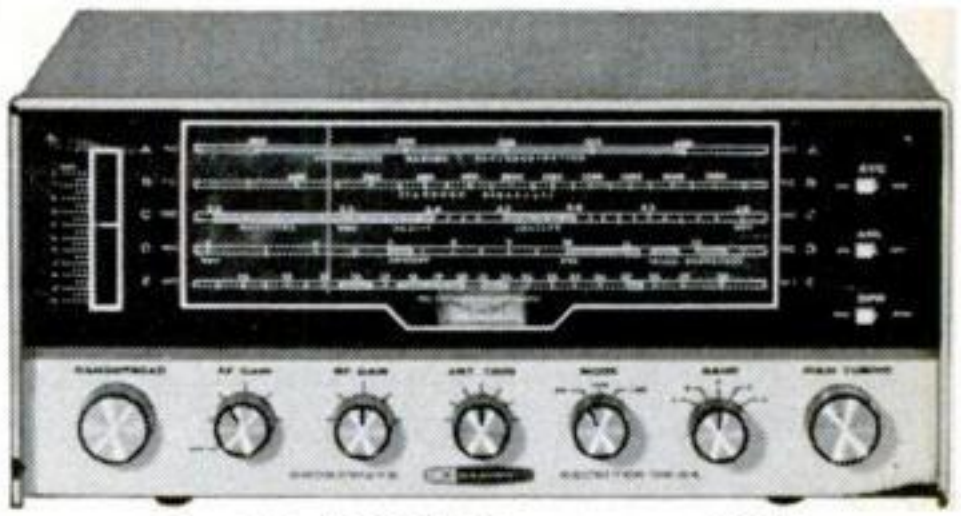

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Across Land and Sea on a Hovercraft Ferry

[Continued from page 75]

She'd settle down like a squatting hen."

"Would we float?"

"Oh, sure. This craft has a three-part, flat-bottomed hull. The center part is filled with plastic foam. Each outside section has six watertight compartments."

The pilot closed the entrance and started the turbojet engine, a marine version of GE's T-58 power plant generating 1,050 pounds of thrust. As the rearward-facing four-bladed propeller spun faster, so did the lifting fan geared to it and set horizontally in the hull behind the cabin.

The lifting fan forces air into the skirt-like tubing that rims the Hovercraft, and also into a cross-shaped, inflatable structure underneath it. The narrow trailing ends of the skirts are open, and there are also fairly large ports in the fabric high on the inner side. Air rammed into the skirts by the lifting fan simultaneously fills them and bleeds out both through the bottoms and the inner ports.

Off and away. In a few seconds, our vehicle did a gentle "push-up" and began drifting across a concrete strip at Oakland Airport. There was a surface wind from the northwest, a temporary nuisance as our course lay due west. The Hovercraft turned its nose into the wind and sidled along the runway like a skittish horse until we got up enough speed to give its rudders bite.

Another aspect of Hovercraft control is the curious skirt-lifting steering process. By working a control, the pilot can spill air from under any corner of the craft, or from under both forward, side, or rear corners at the same time. The craft dips in the direction of the spilled air.

Off we glided across the airstrip, out over a field of stubble and rubble, up and over a slightly elevated highway, down across a damp beach, and out over the sparkling bay. The ride was astonishingly smooth. and I felt none of the surface irregularities.

As we moved off the beach and out over the water, a fine cloud of spray like smoke rose around us for a second or two, and the big windshield wipers swept into vigorous action. However, the spray was flung behind as we rapidly gathered speed.

When we finally came down to earth back at Oakland, it was evident that getting there by Hovercraft is more than half the fun. The car trip home seemed unreasonably bumpy. ■■

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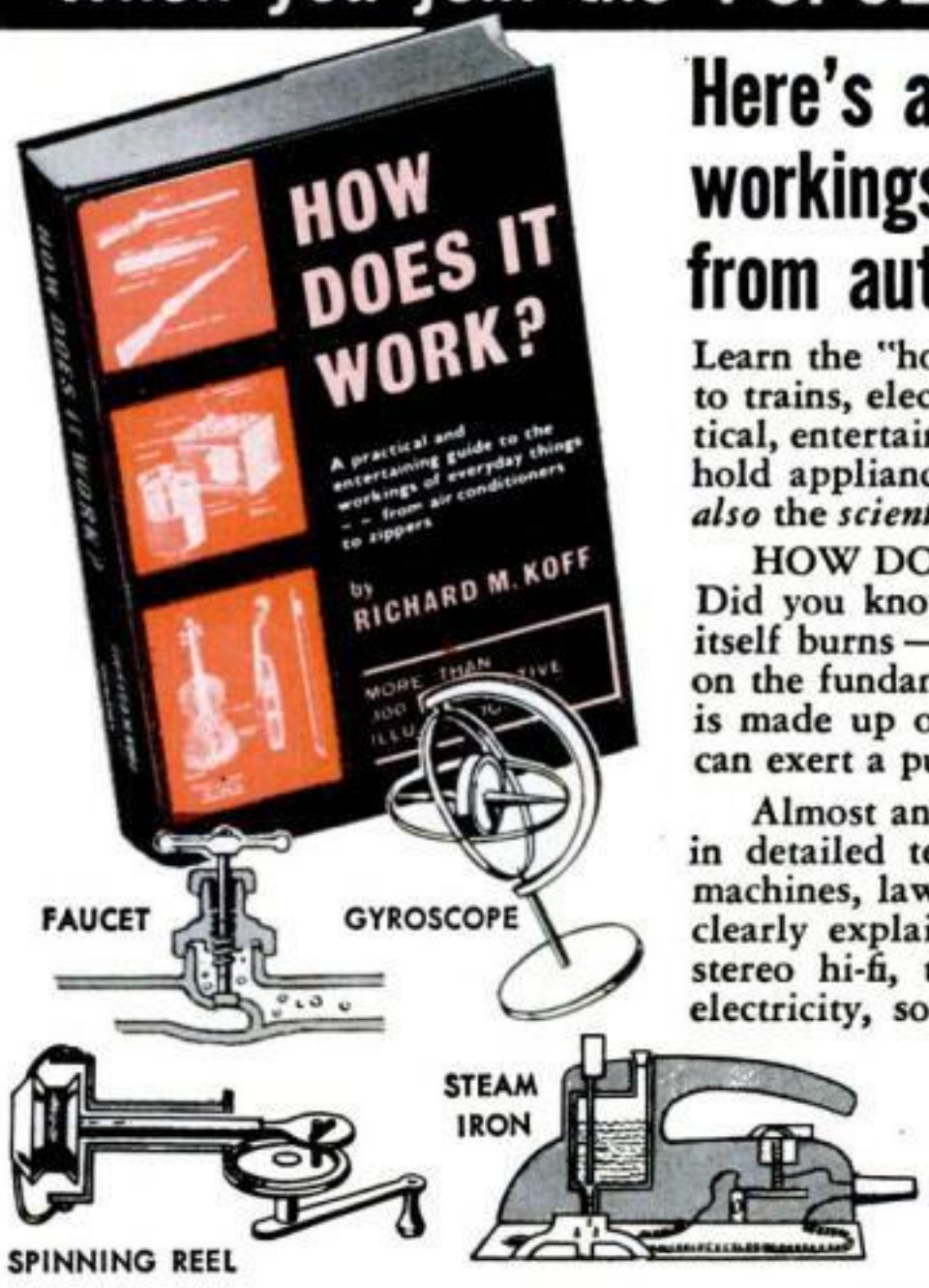
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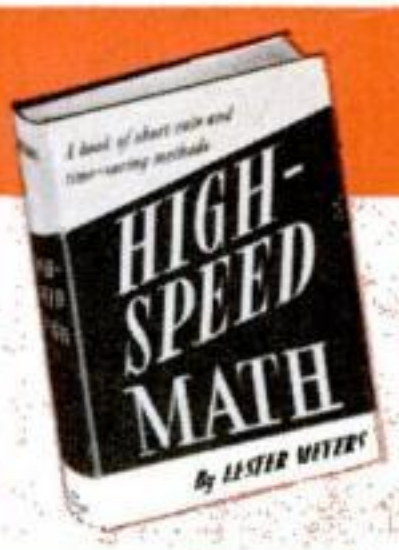

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The World's Fastest Man on Water

[Continued from page 99]

I tried out the new rudder early in April, 1964, and it worked like a charm. Hustler made beautiful 180-degree turns at only 35 m.p.h.

But—and here's the big lesson the accident taught us—when the power was off, the thrust deflector was useless, even with the engine still windmilling. Steering control was gone, and, to make things worse, the water fin kept the boat headed on the course she was on with the jet running.

Another discovery that gave us pause for thought came many months later when I was tearing down the engine for overhaul. The return spring on the throttle was badly out of shape—the engine could not be throttled all the way down.

Smashup. What happened on April 14, 1964? First, I was caught off guard by the tremendous acceleration of the jet engine—it's deceptively slow at low speeds but picks up at a hair-raising rate as it gains momentum. I must have tried to throttle down the engine, but the bad spring prevented that, so I apparently cut the fuel supply (investigators later found the cutoff closed).

I then tried to make a sharp left turn, only to discover that without power I couldn't steer, and the boat was headed straight for a point of land. I tried to climb out, for the quick-release latches on the inside of the canopy were undone, but Hustler stumbled through shallow water at the end of the point and threw me out.

As a result of these misfortunes, Hustler now has a water rudder 15 inches long and eight inches deep, and a thickened water fin. This rudder will steer the boat at all times and will be moved by the same hydraulic system as the thrust-deflector rudder. They'll synchronize when the engine's running.

The overhauled engine has a new throttle spring—the best we could buy.

Another addition is a new drag-chute system to stop the boat faster in an emergency; it's stowed in the base of a tail modeled on that of the F-104 jet fighter.

The same team that put Hustler together and restored it to life is convinced, to a man, that the boat and I can set a new speed record. Eyewitnesses agree that we were traveling between 275 and 300 m.p.h. just before the accident. The present record is only 276.33 m.p.h. ■■

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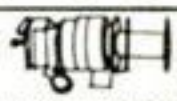

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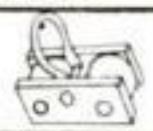

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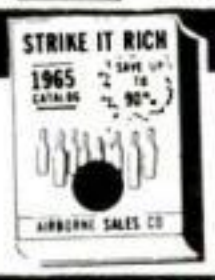

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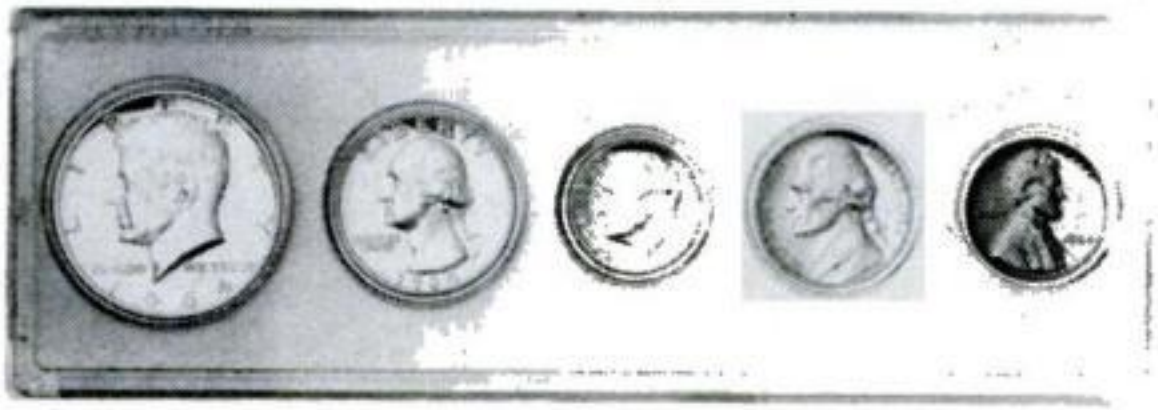

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I Survived a Jungle Survival Test—Could You?

[Continued from page 65]

Next day I was able to gather my strength to take a few more notes on Monie's survival tips. Some of the tidbits:

- Nearly all fungus that grows on trees is edible, but because there is at least one exception—the jack-o'-lantern—best steer clear of all fungus. Ignore mushrooms completely.
- Lichen is edible, though nearly tasteless. But boiled up with a little chili powder, it becomes palatable. Grasses have little or no food value, but can fill out a stew, fill up a stomach.
- Water can be found in the juice of young cane stalks, vines, cactus, and the fruit of most trees. Or you can drink the blood of any mammal or turtle. Don't ration water. Drink when you need it to avoid dehydration.
- The meat of any animal with fur is edible. Most insects can be eaten.
- Eat the legs of frogs, the hindquarters and tails of lizards, the legs and necks of turtles. Stay away from toads.

By this time I was getting plenty hungry, and the K rations were running low.

For variety in our vegetarian diet we leached some acorns (to get rid of the bitterness) by boiling them and drying them in the sun. They were still somewhat bitter, but not too bad when augmented with palm buds and the insides of a few pine cones.

The best meal came the day before we were to be picked up. The evening before, Sergeant Monie was bringing up the rear when a deer bolted away from us. Suddenly two shots rang out in quick succession from Monie's little fold-up .22, hidden until now in his pack. He, too, evidently was beginning to feel a little starved.

Golding dug a pit and Watson built a roaring fire. Took all night to cook. But venison for breakfast is great.

End of the trial. Next day, right on time, the old C-47 lumbered in to pick us up. We had walked about 45 miles, had eaten everything from flower petals to lichen, were tired, sore, and I, for one, was lighter. But as I lay back in the plane, absentmindedly scratching my chiggers and picking wood ticks from my scalp, I realized that we had proved, I think, that with a little survival training, a measure of initiative, and a very few essentials, almost any healthy man can get along in the wilderness. ■■

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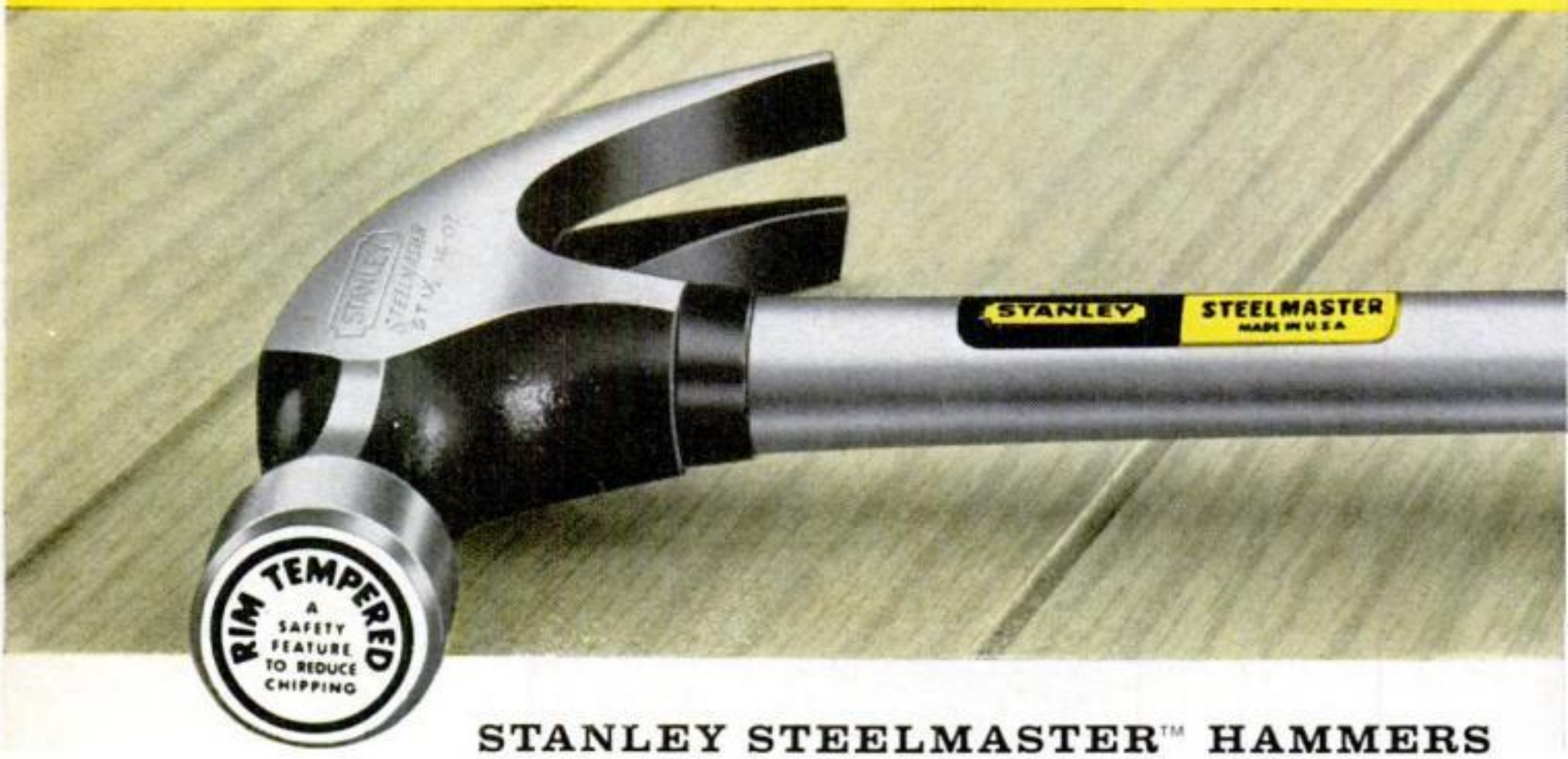

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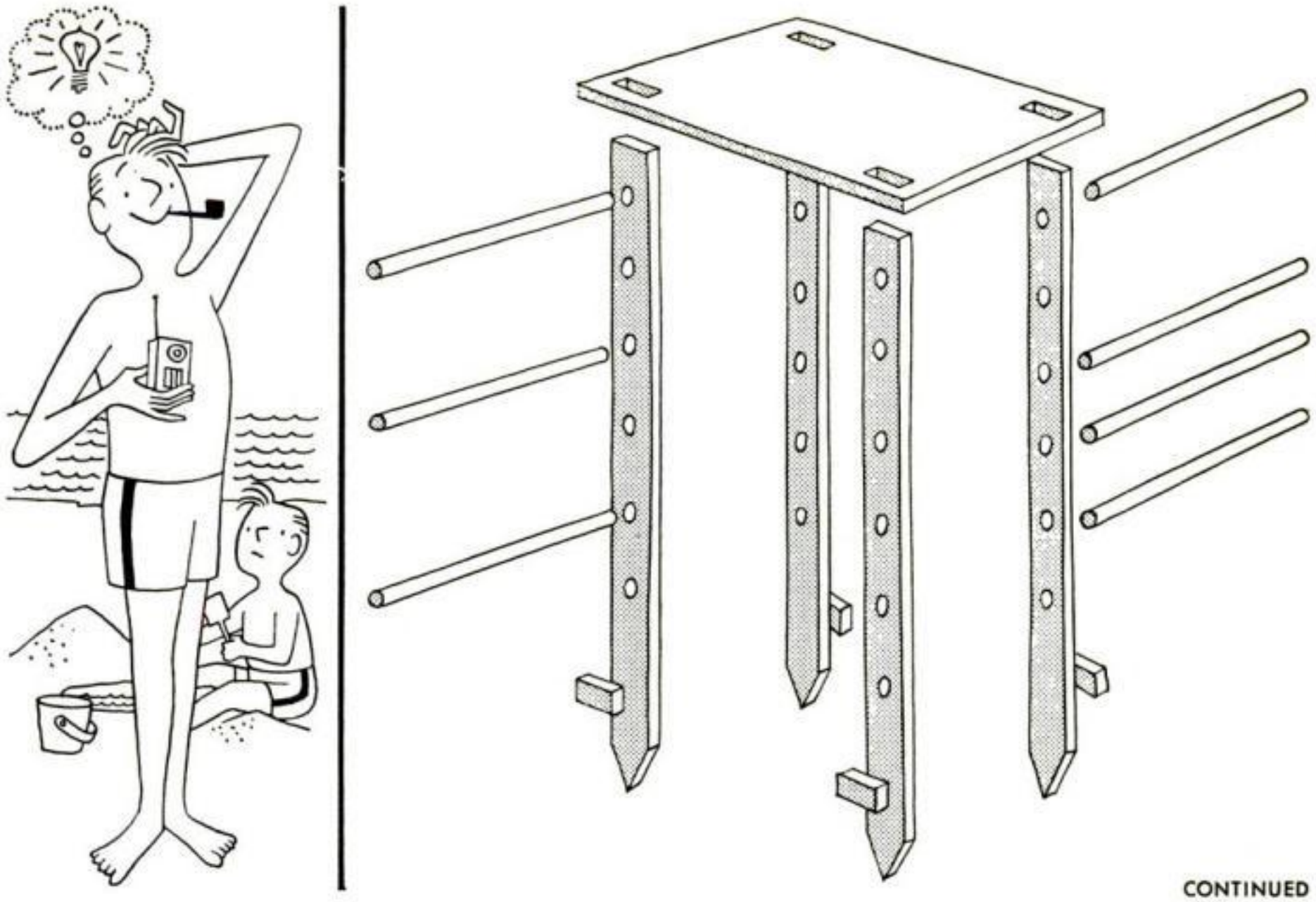

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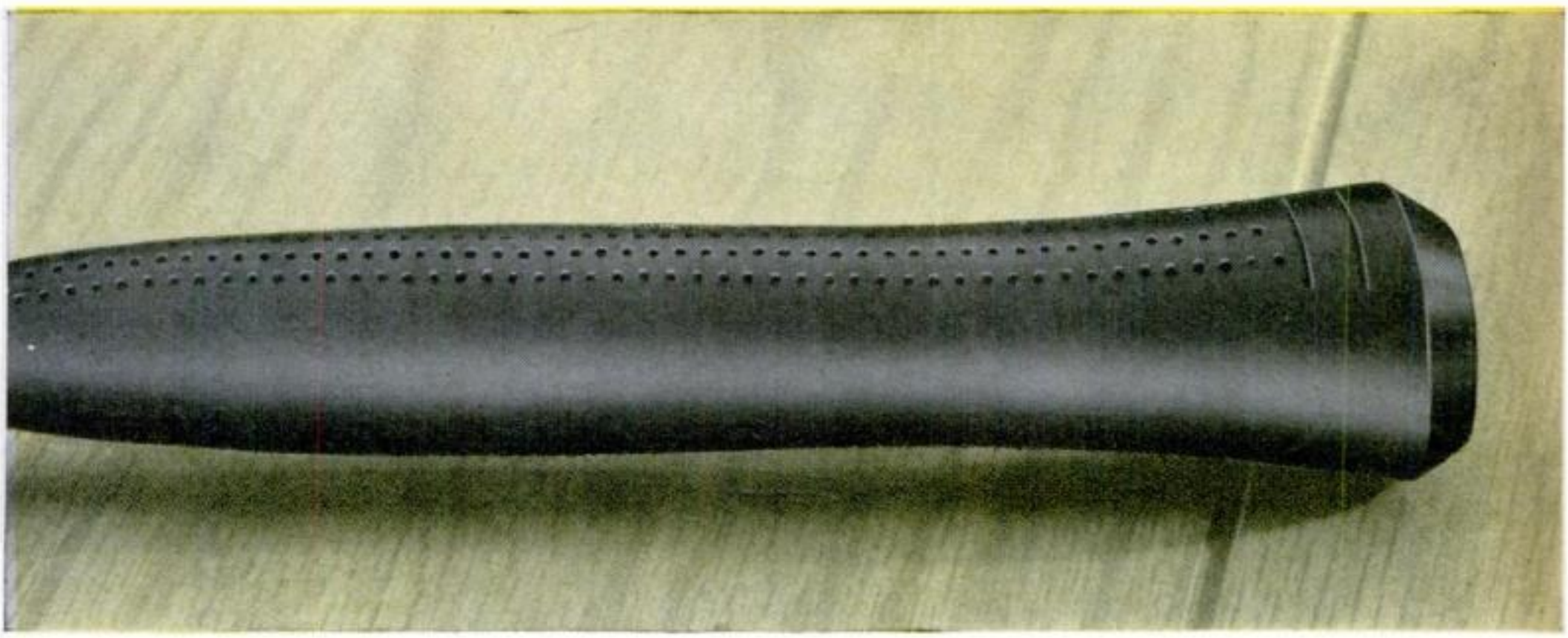

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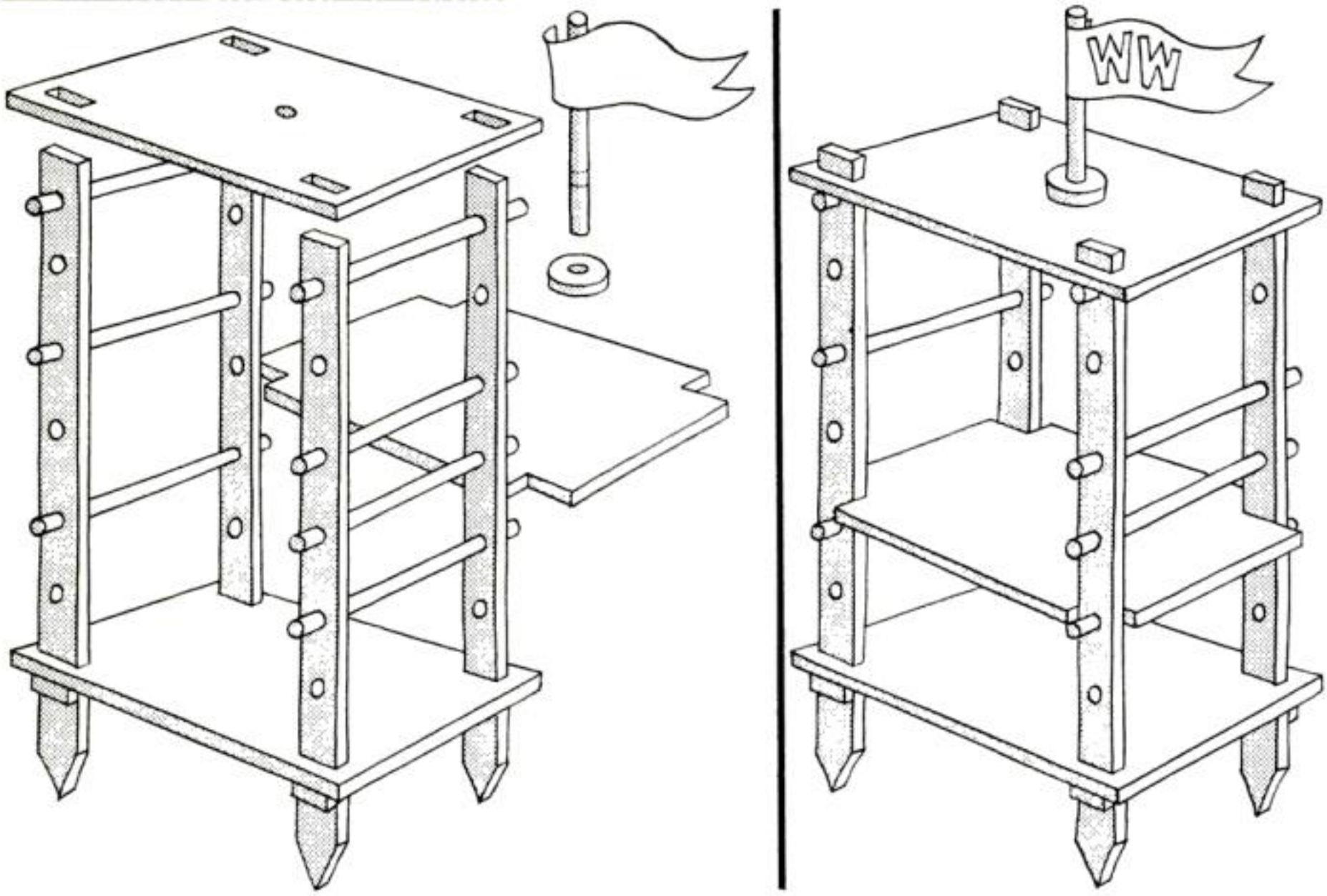

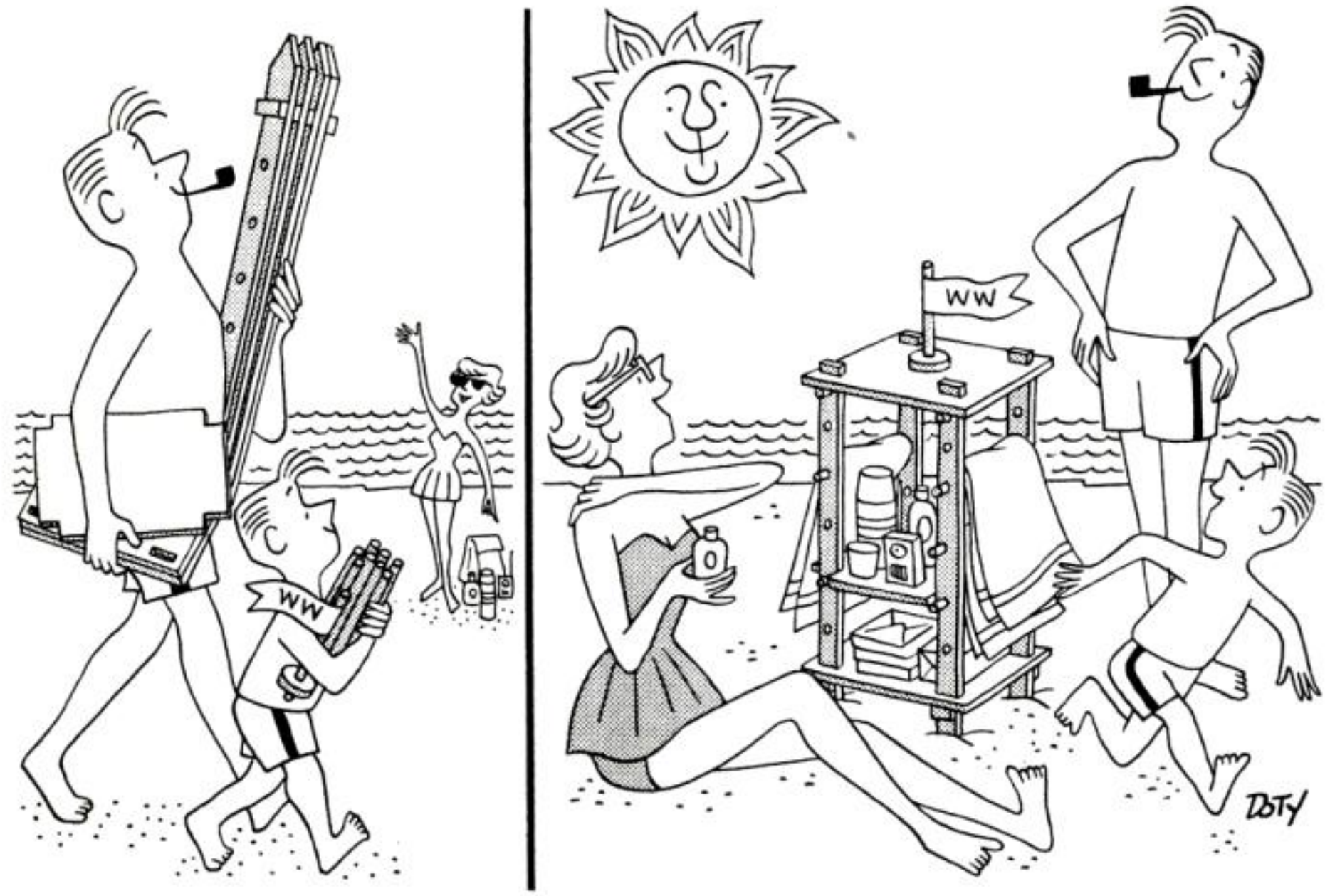

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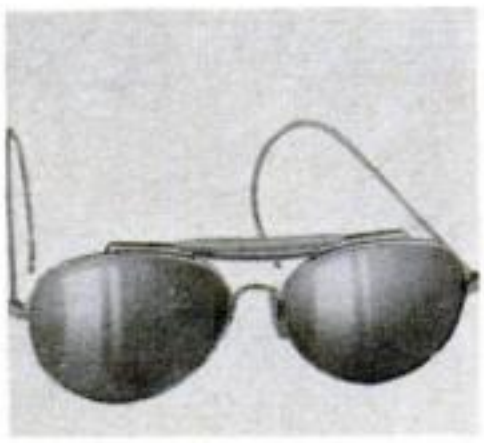

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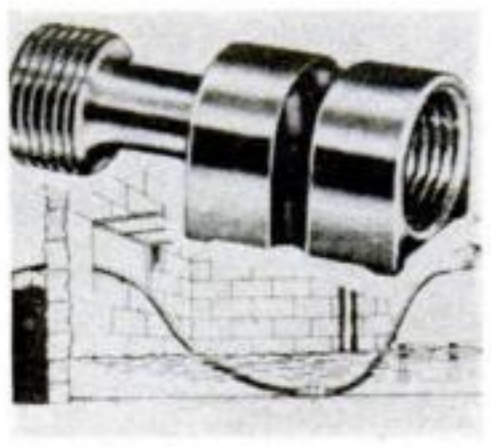

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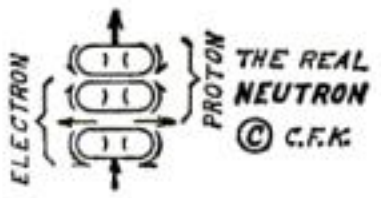

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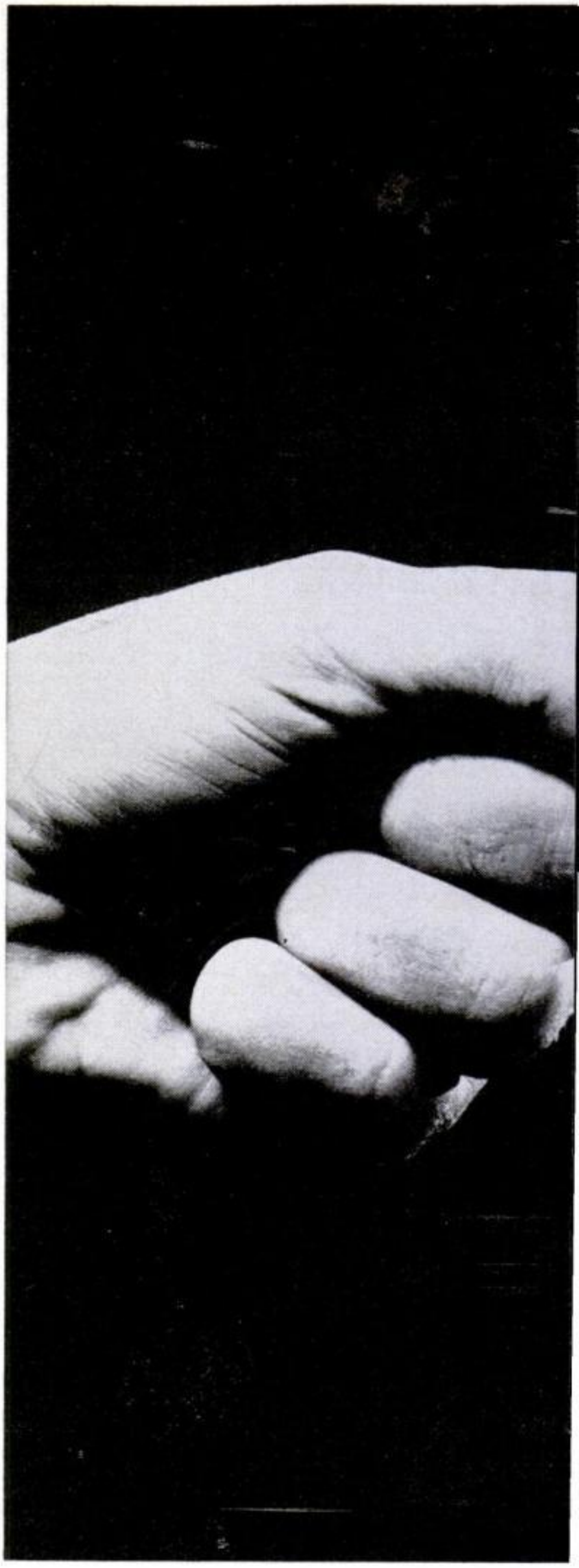

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